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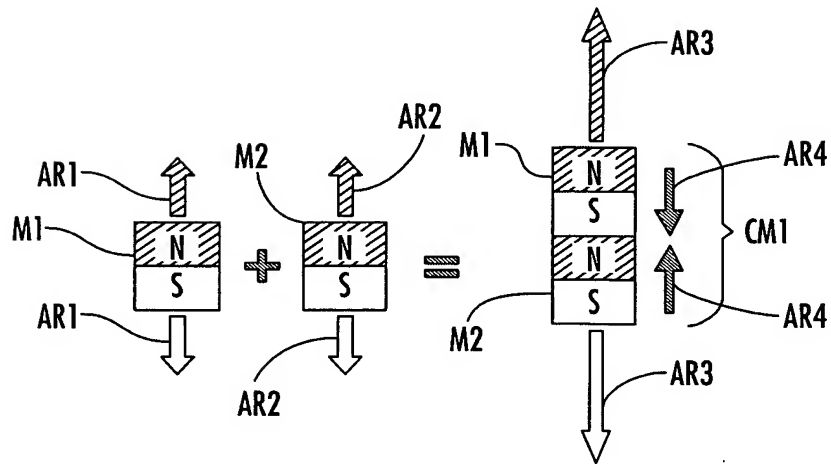


FIG. 1

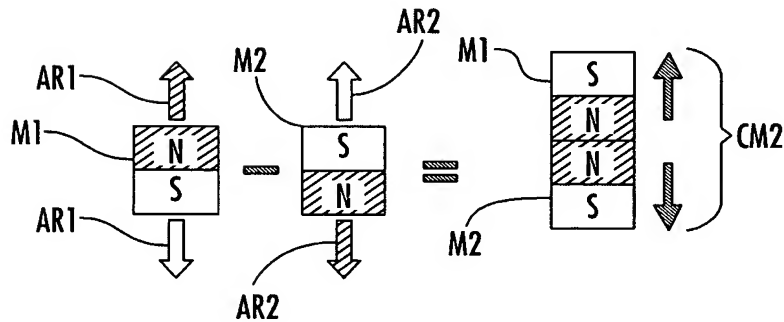
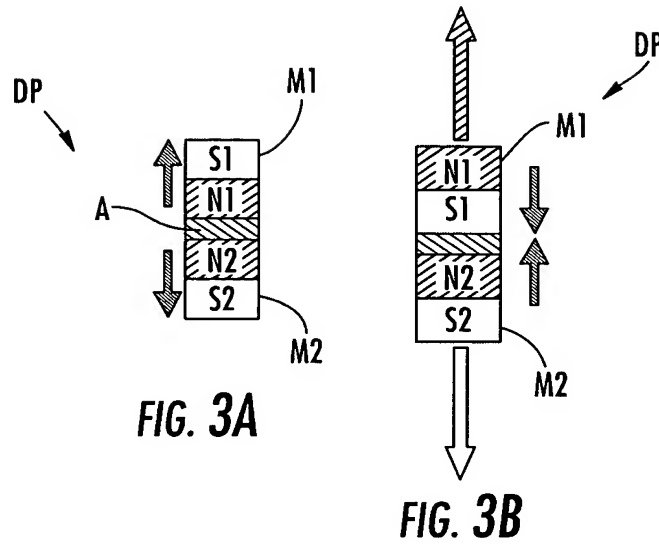
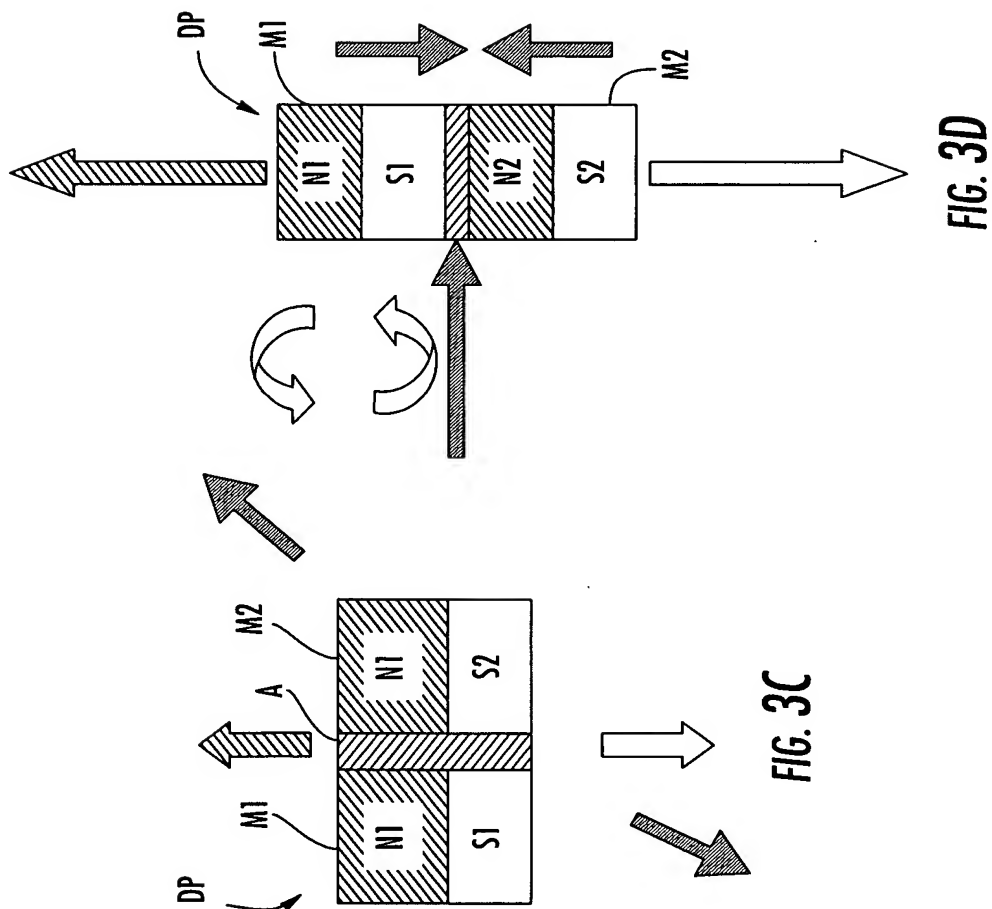


FIG. 2

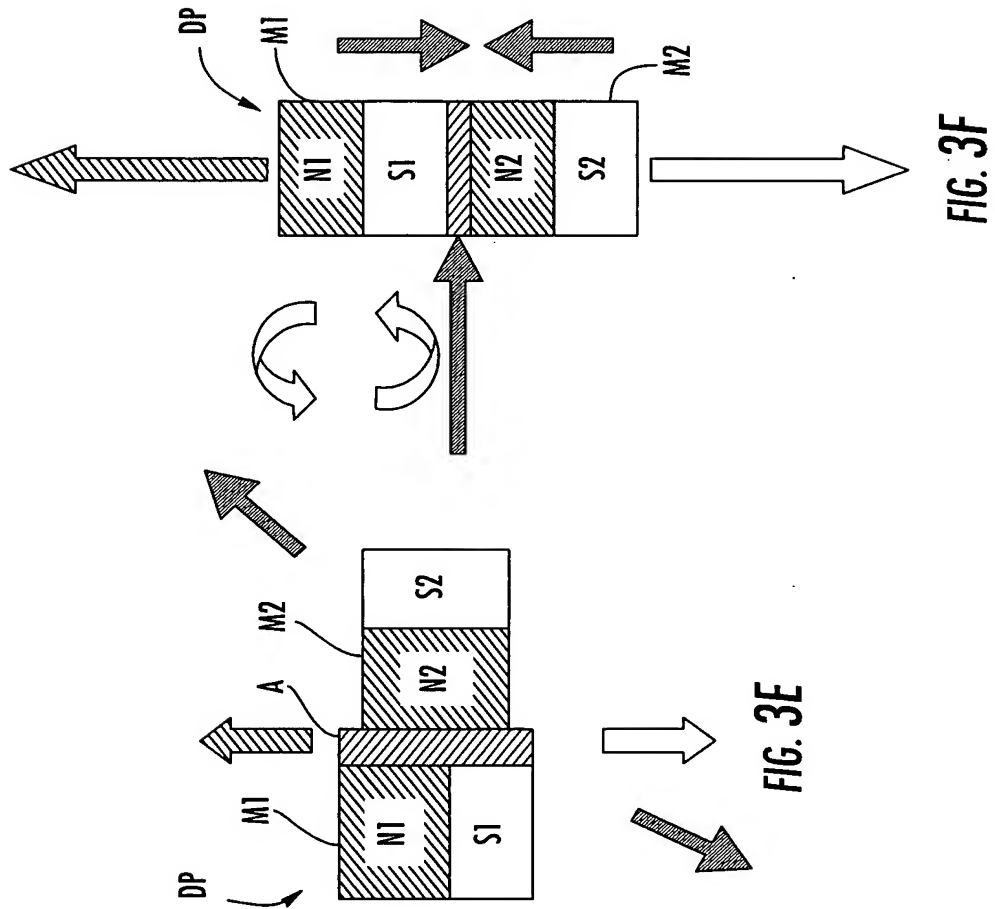
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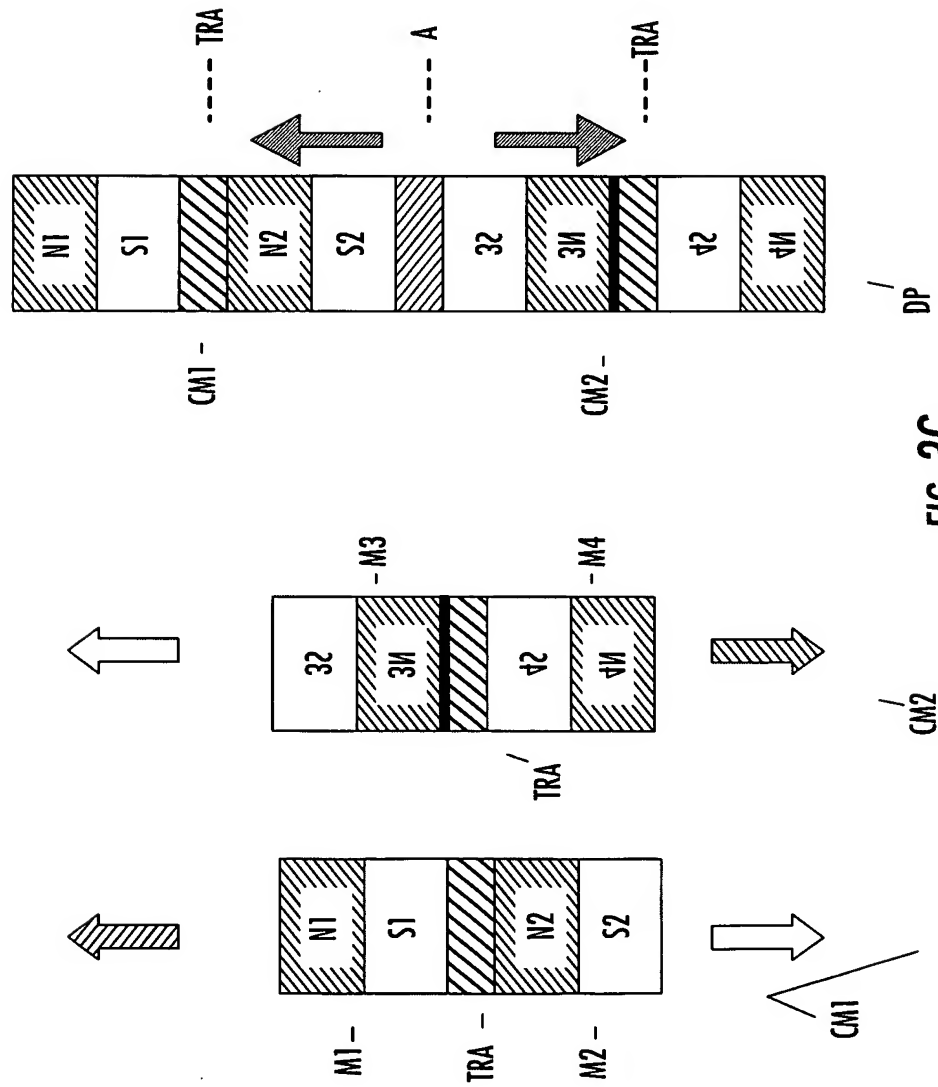
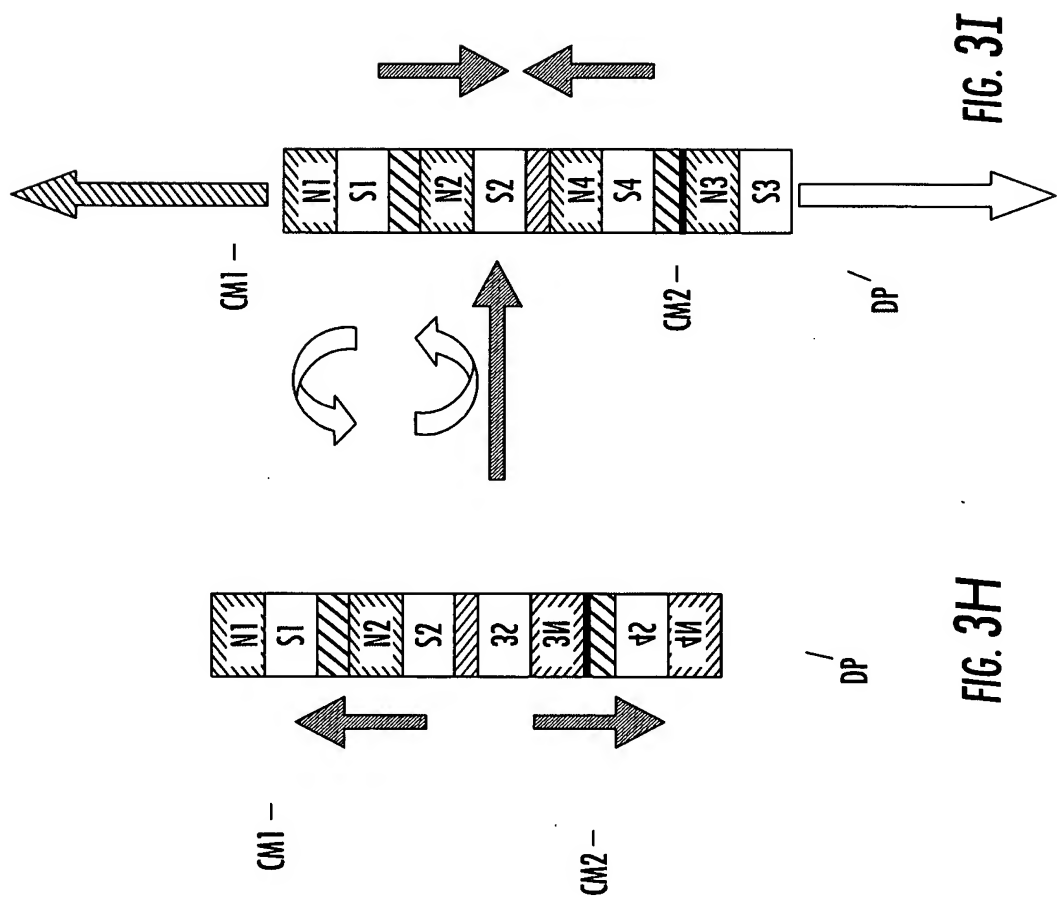


FIG. 3G

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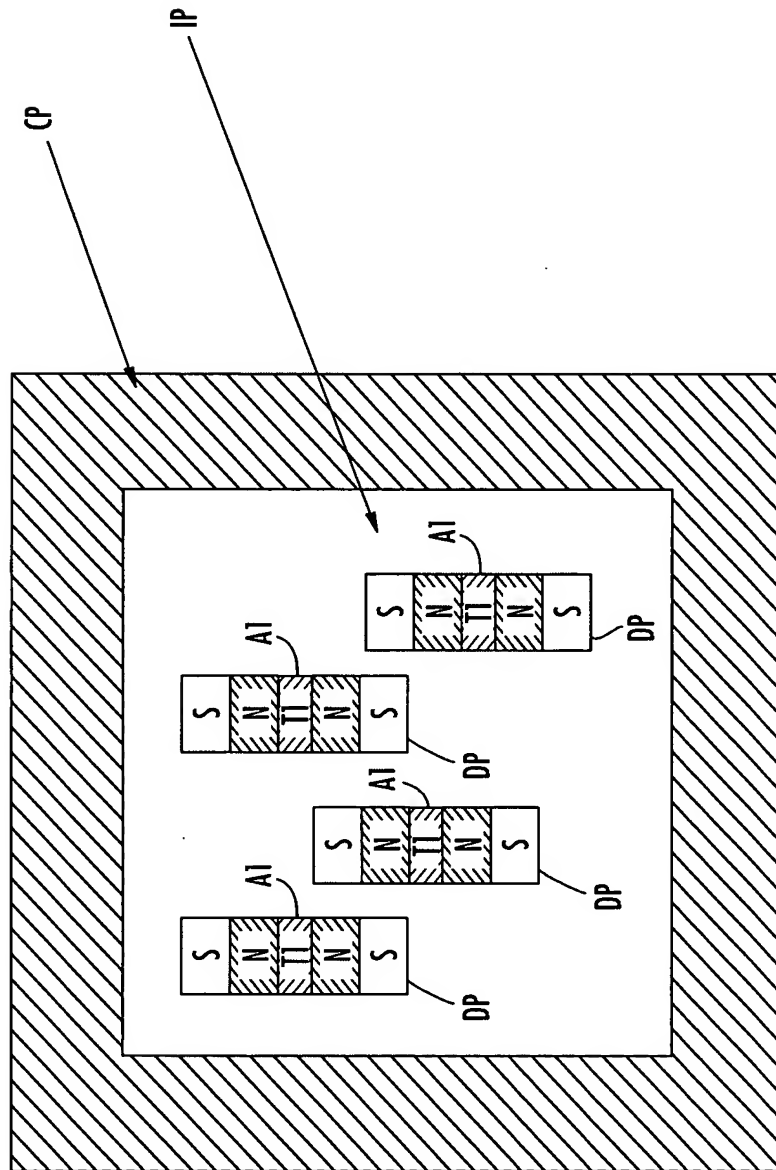


FIG. 3J

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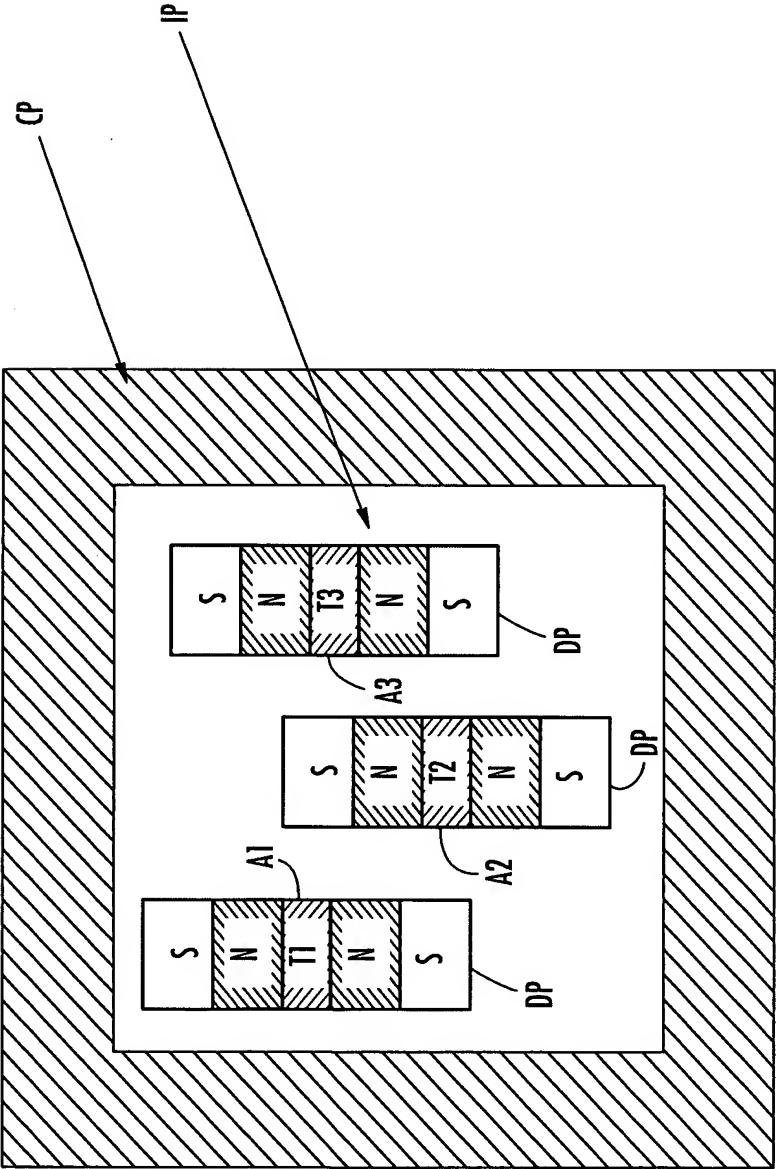


FIG. 3K



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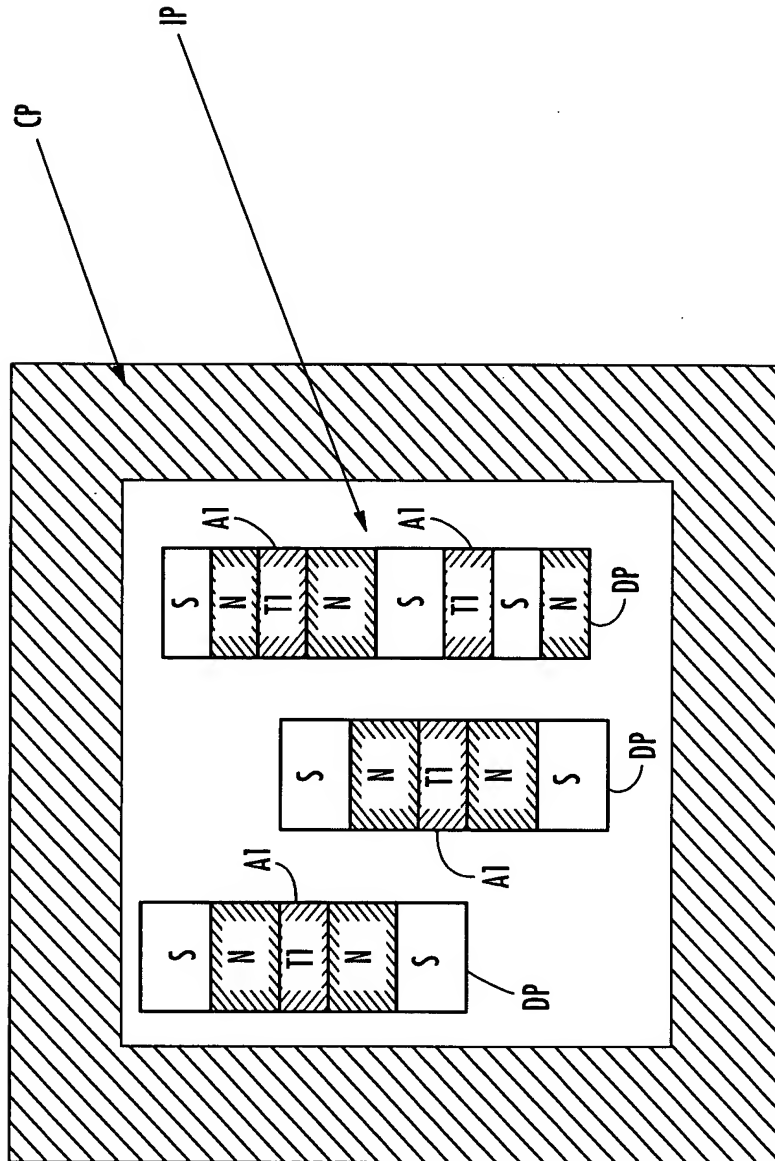


FIG. 3L

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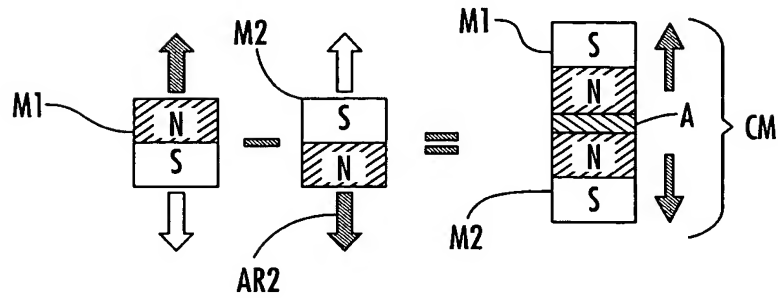


FIG. 4

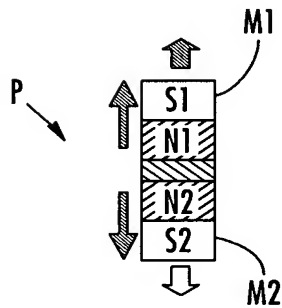


FIG. 5A

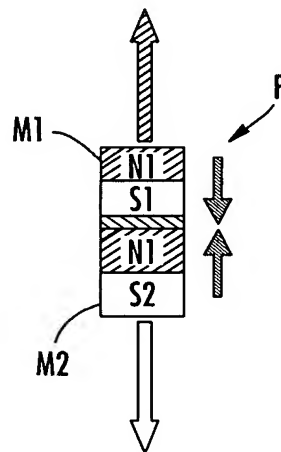
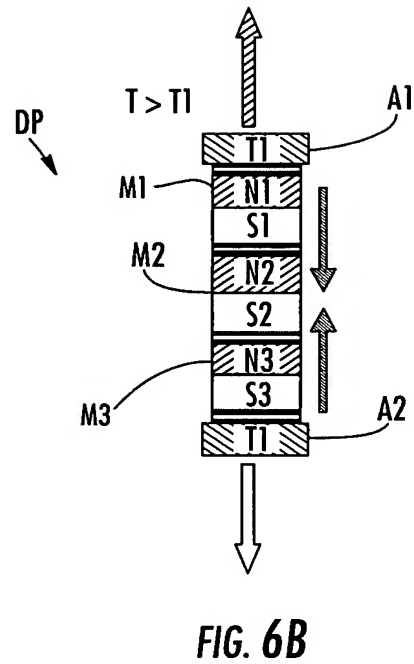
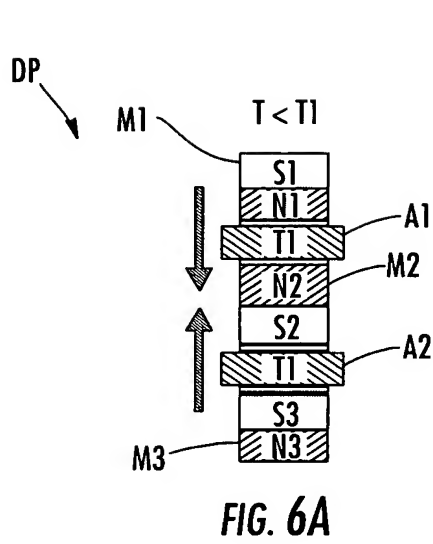
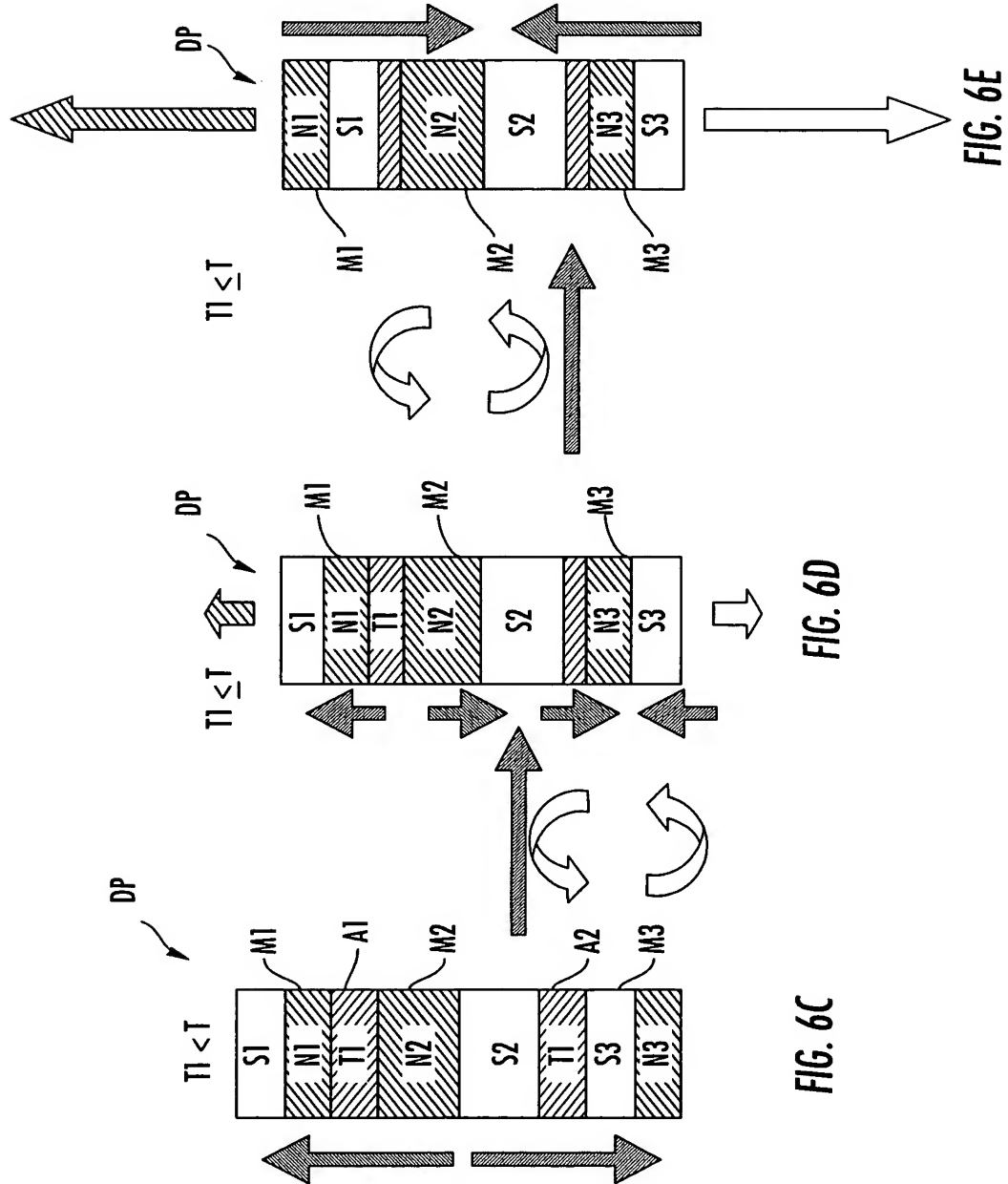


FIG. 5B

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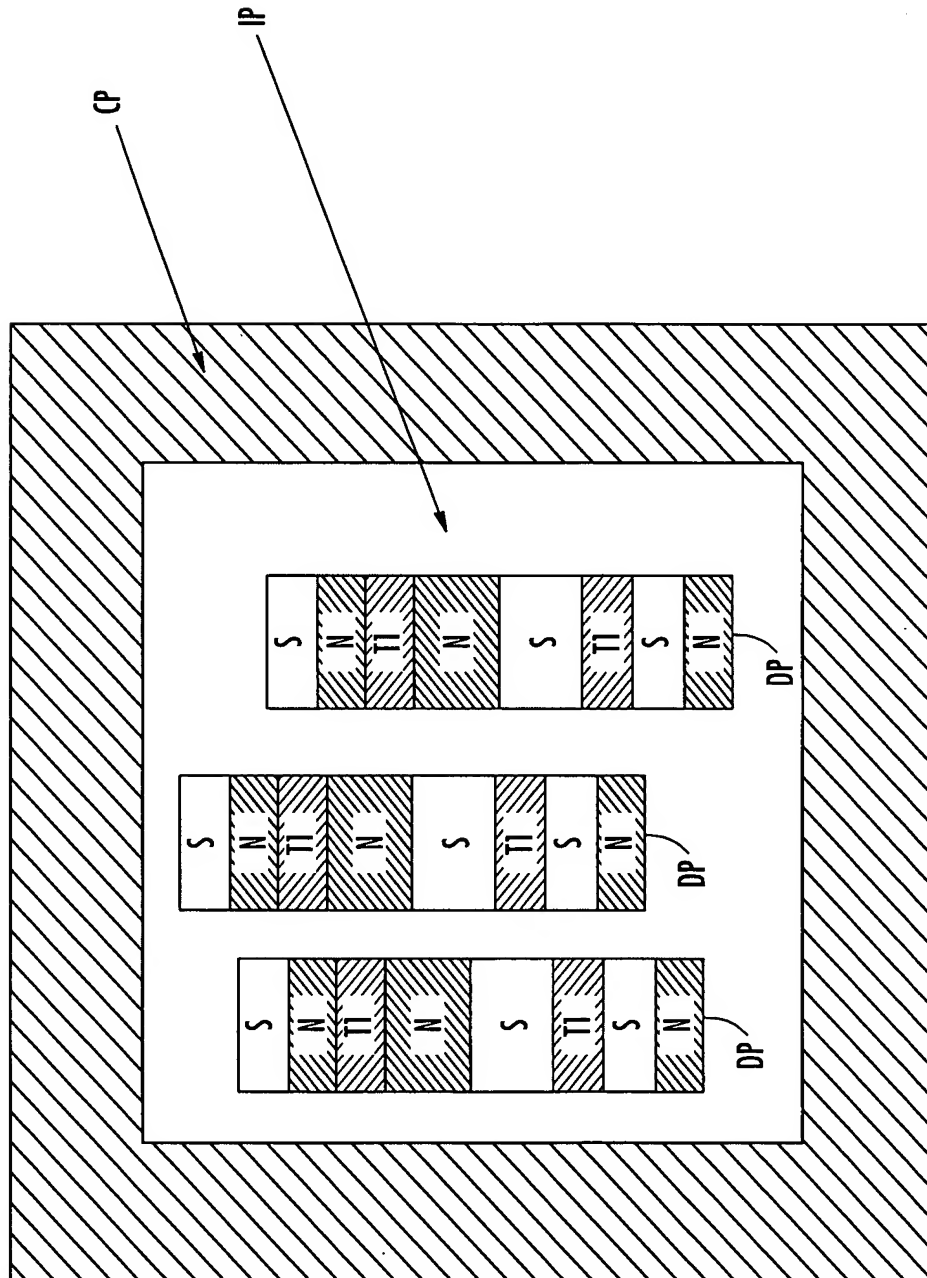
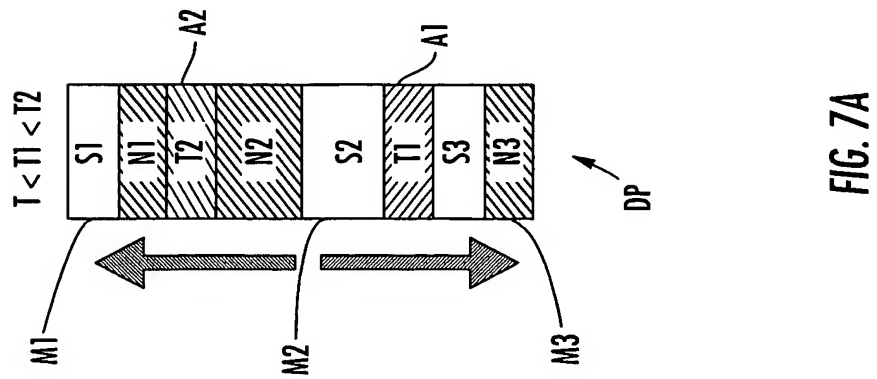
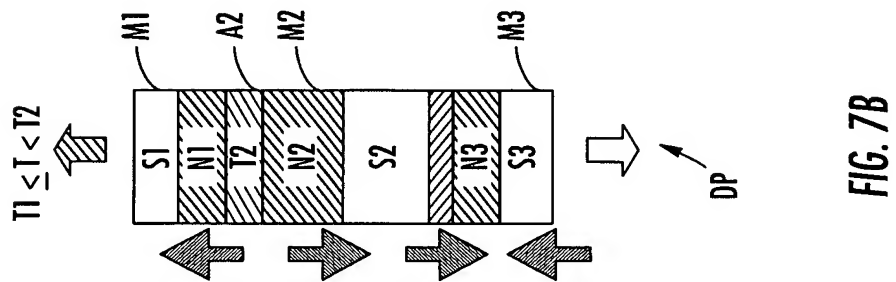
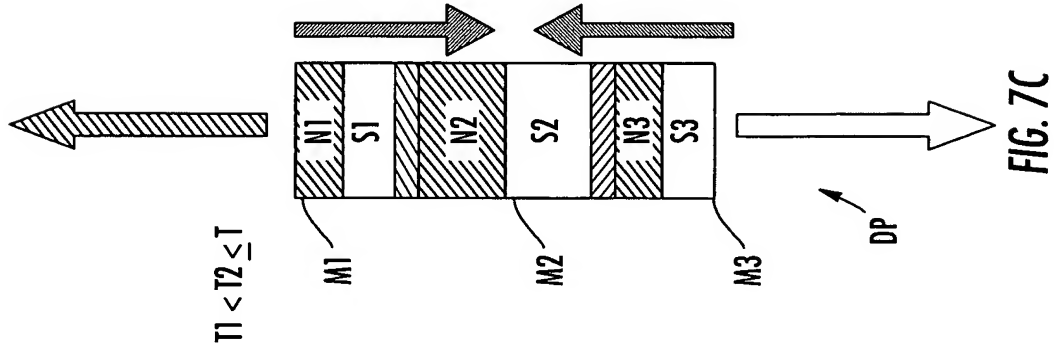


FIG. 6F

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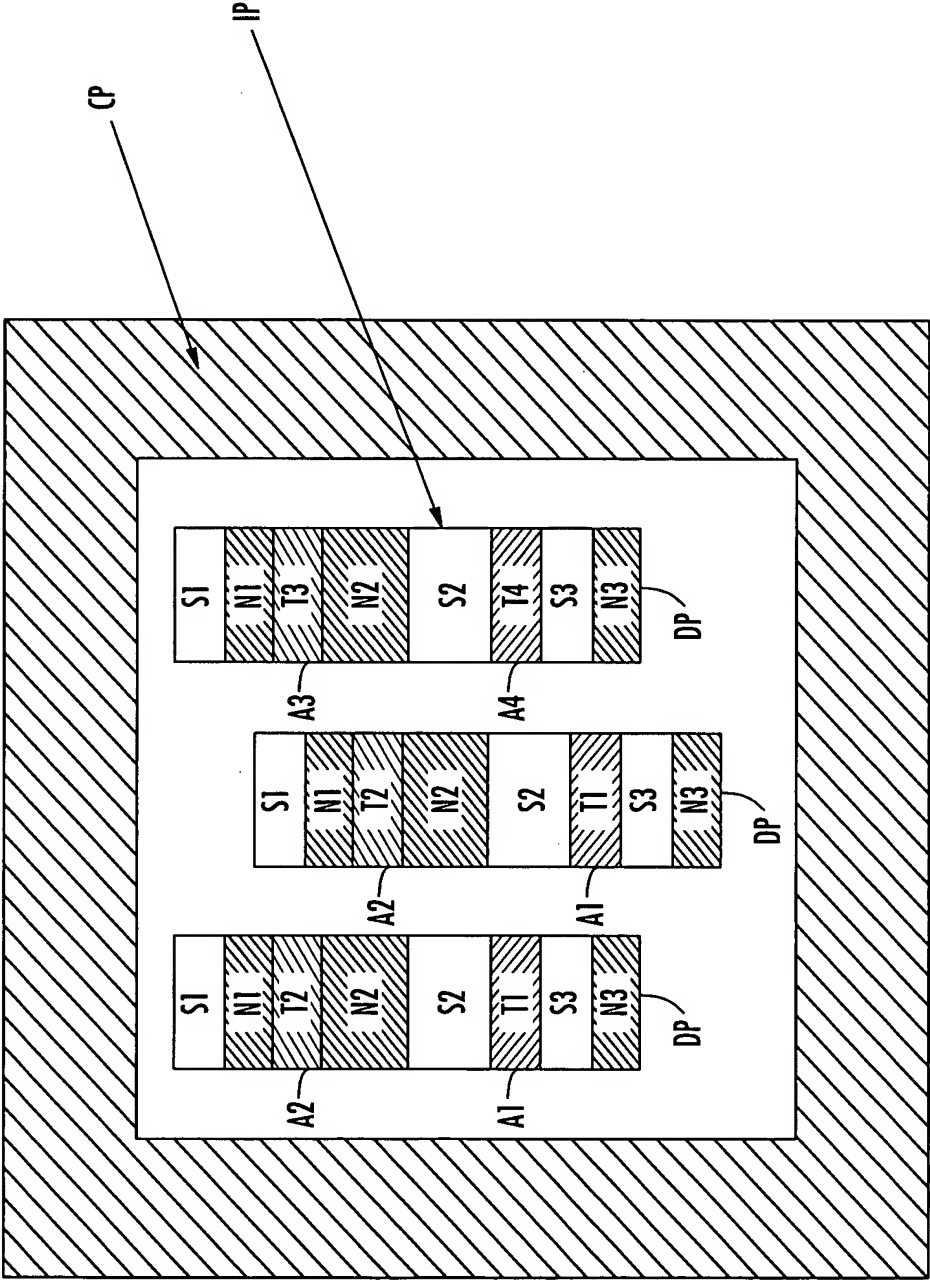


FIG. 7D

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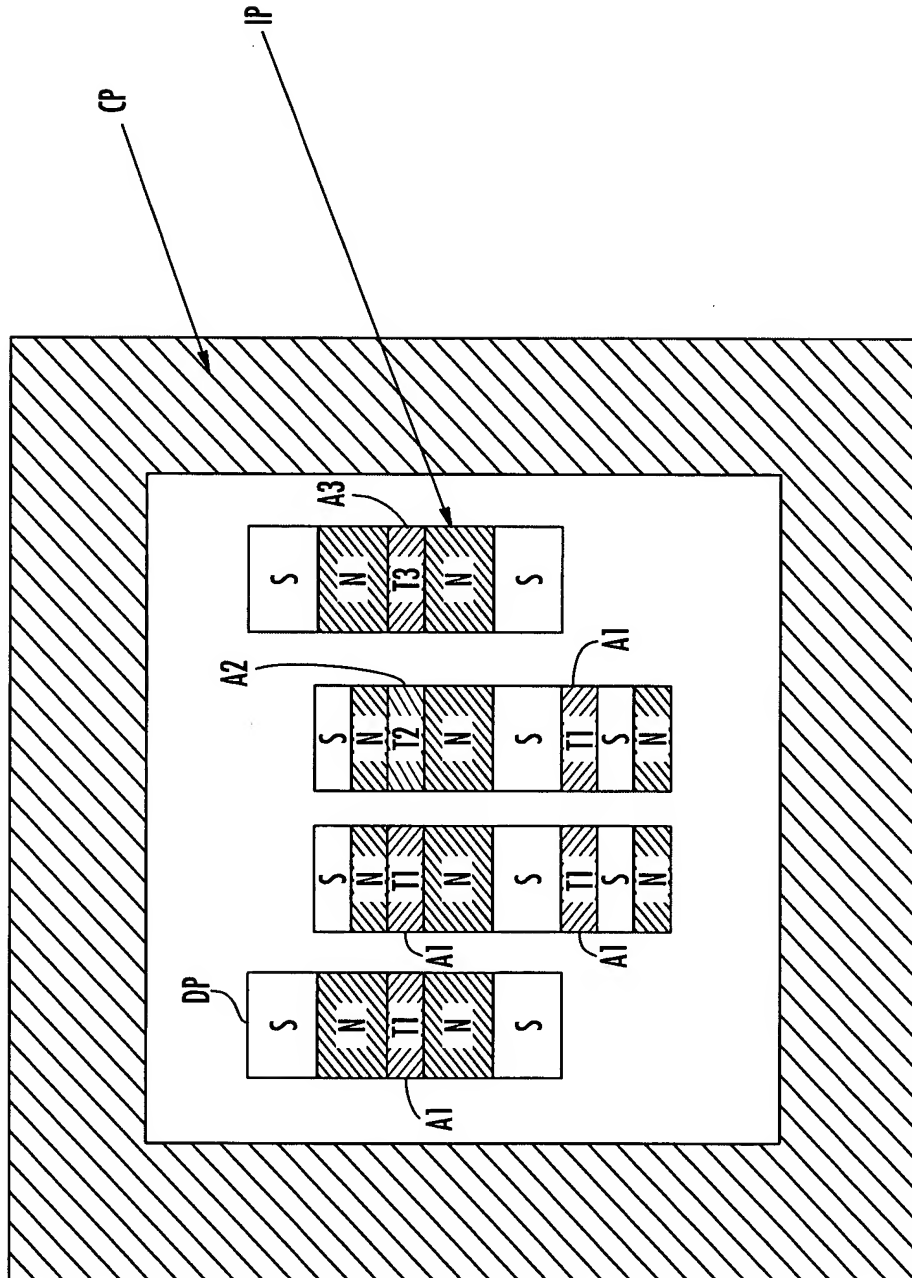


FIG. 7E



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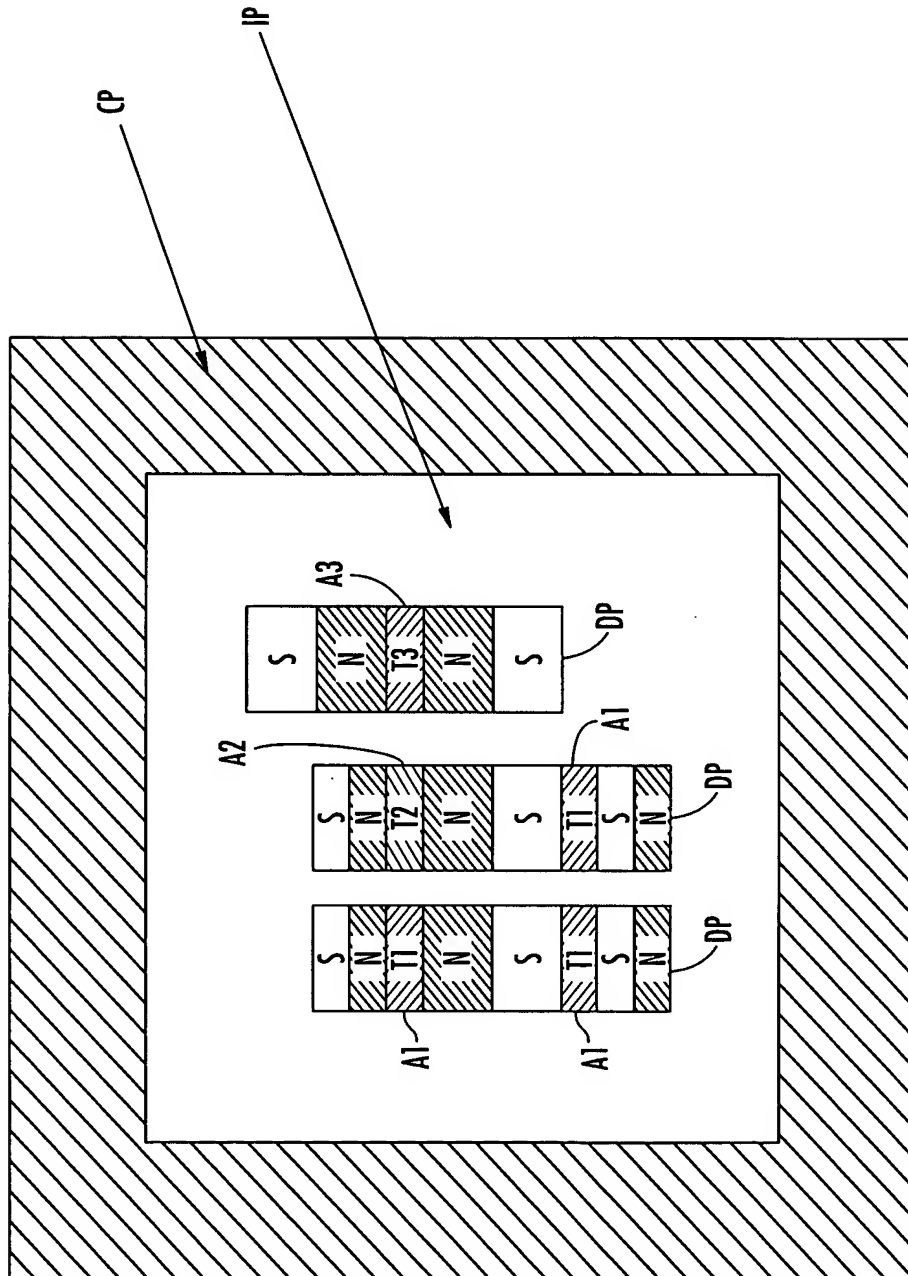


FIG. 7F

REPLACEMENT DRAWING

Title: Methods, Systems, and Devices  
for Evaluation of Thermal Treatment  
Inventors: Palazoglu et al.  
Attorney Docket No. 297/164/2

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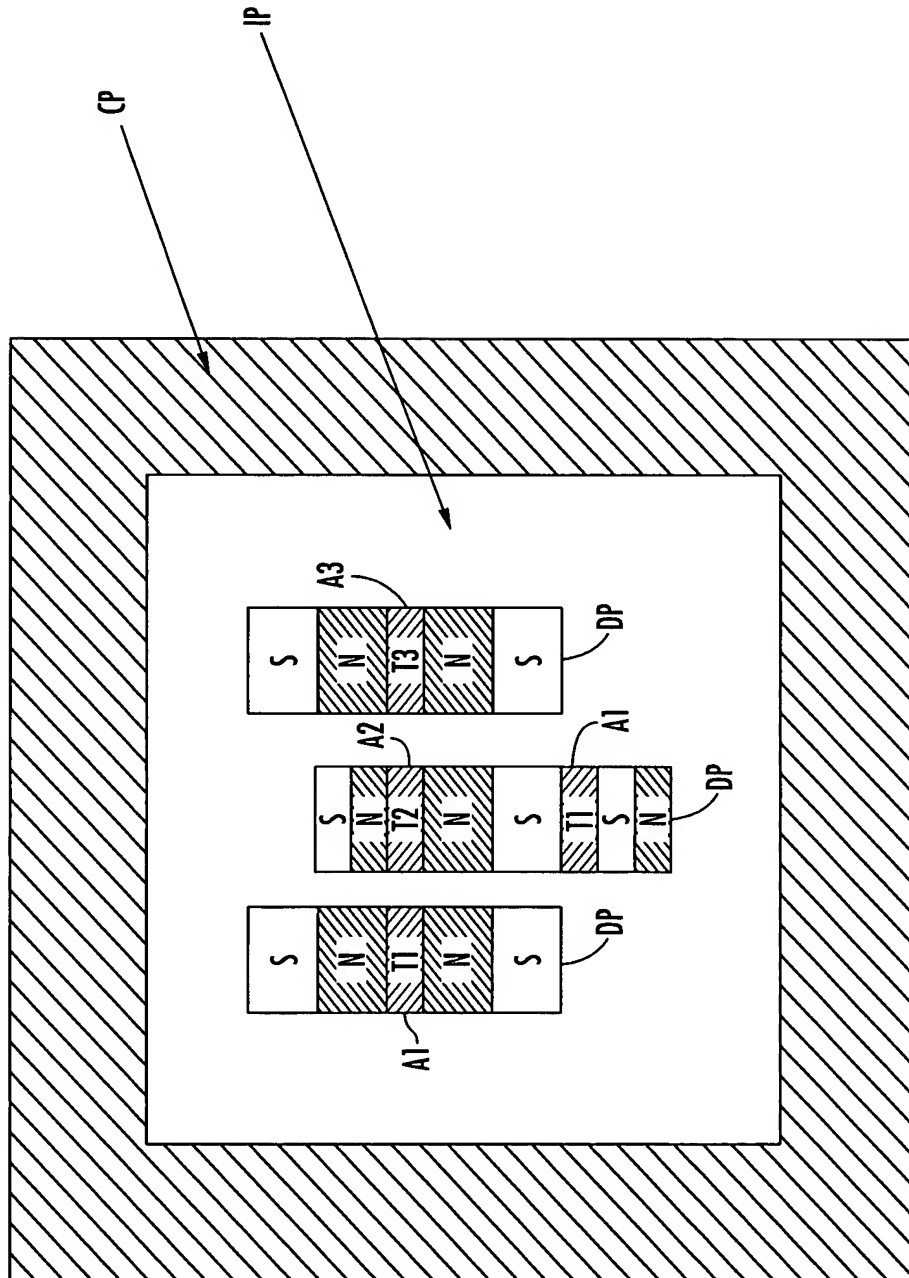


FIG. 7G

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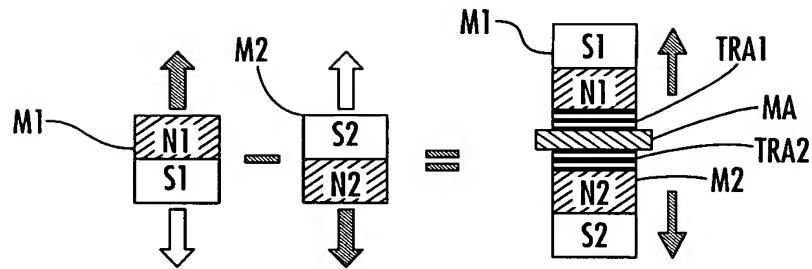
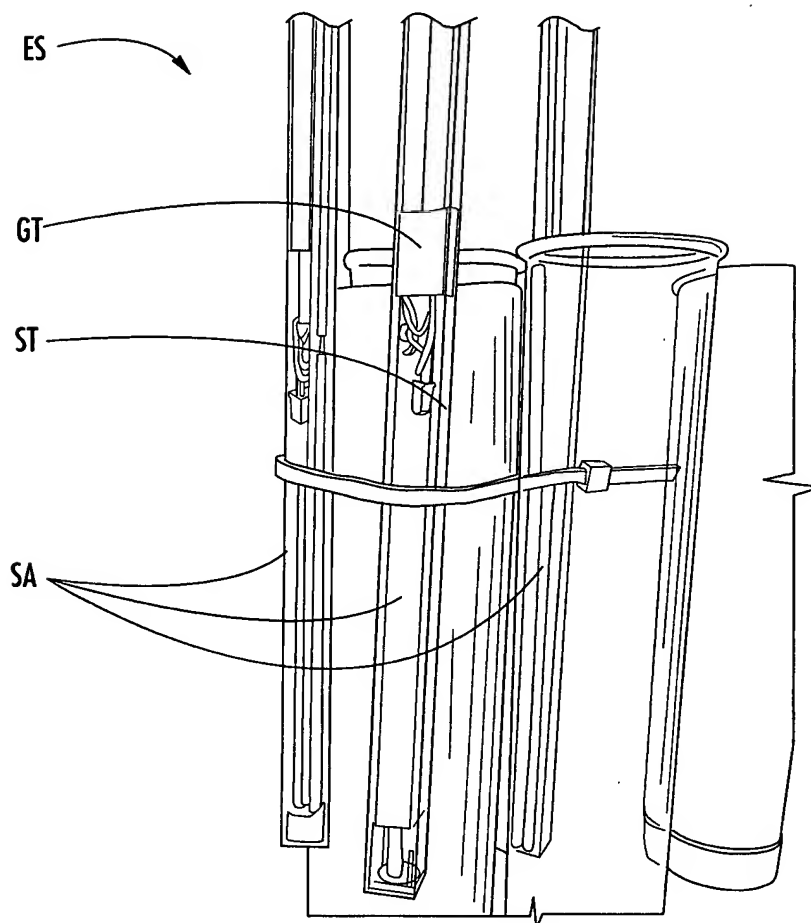


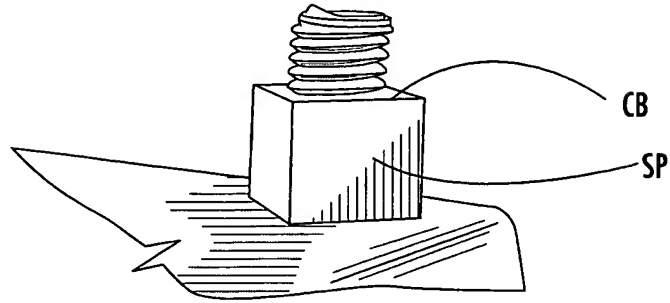
FIG. 8

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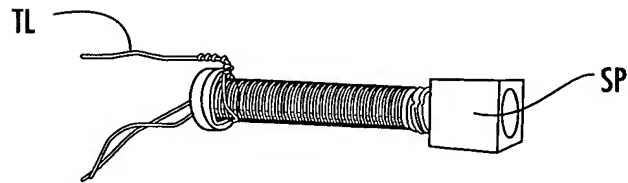


**FIG. 9**

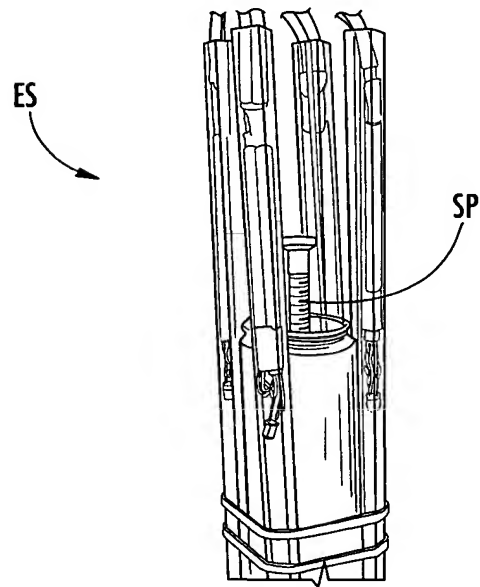
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**FIG. 10**



**FIG. 11**



**FIG. 12**

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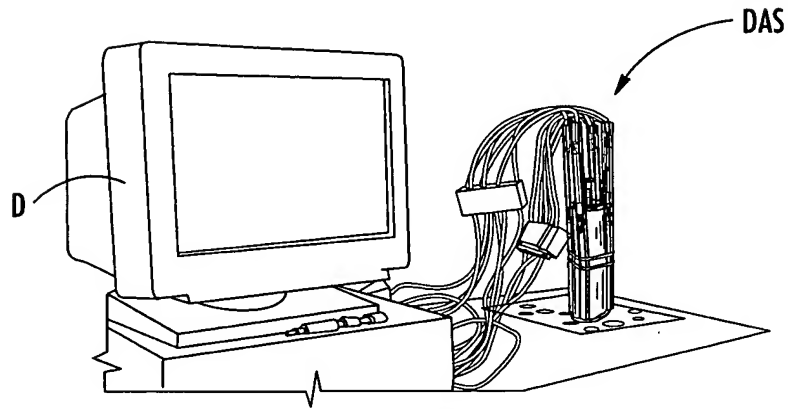


FIG. 13

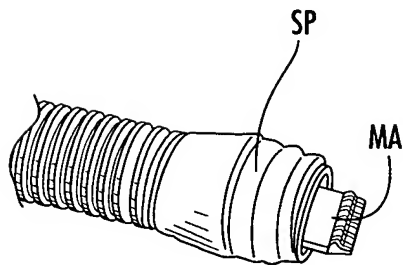


FIG. 14A

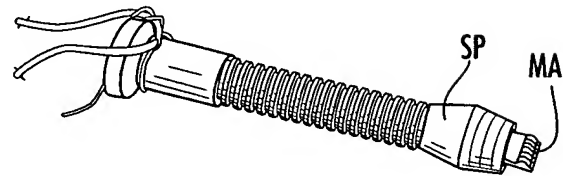


FIG. 14B

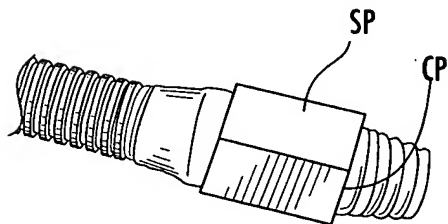


FIG. 14C

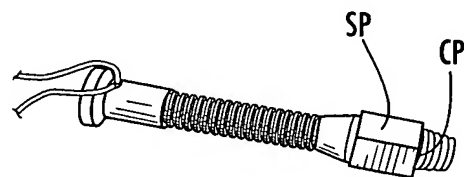
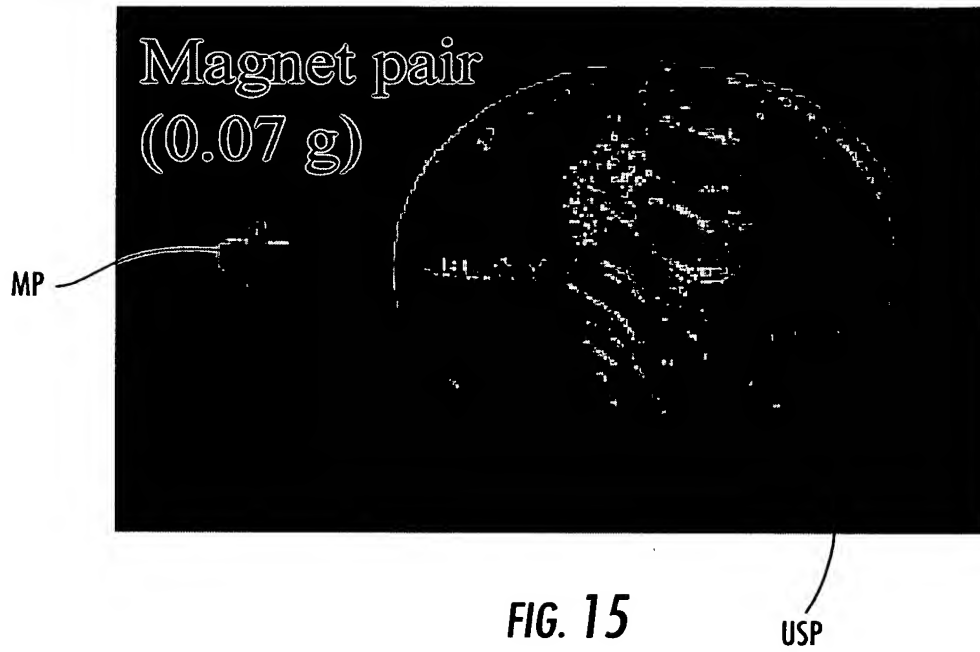


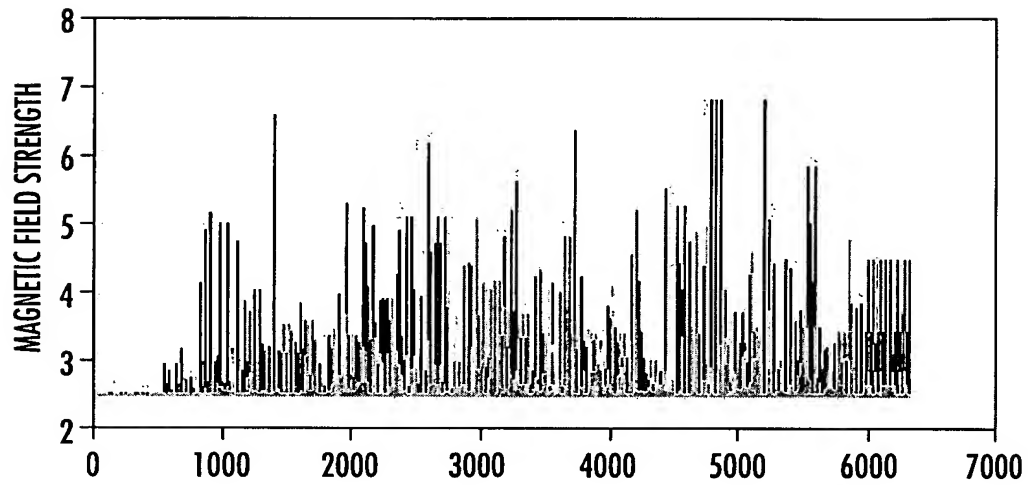
FIG. 14D

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NATURAL



**FIG. 16**



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GLUED

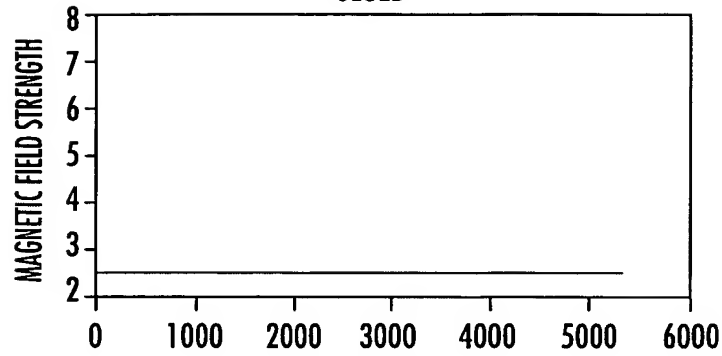


FIG. 17

GLUED AND HEATED

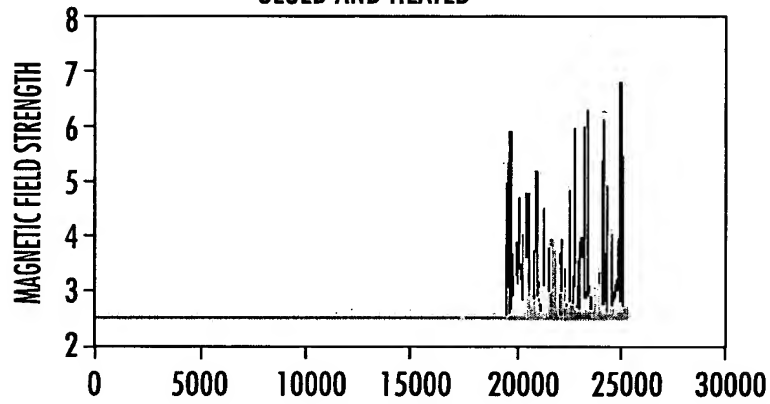


FIG. 18

GLUED AND HEATED  
IDENTICAL MAGNET PAIR

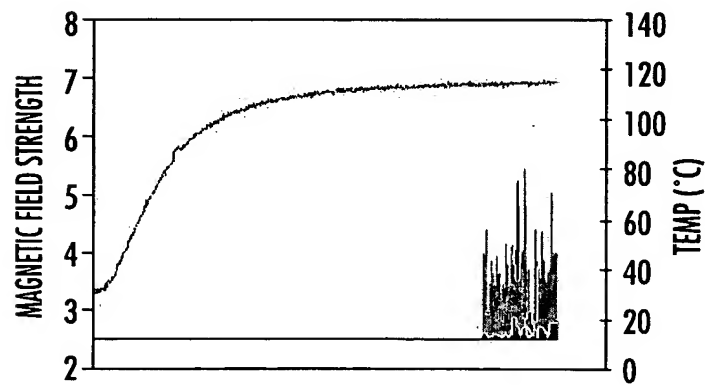


FIG. 19

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GLUED AND HEATED  
NON-IDENTICAL MAGNETIC PAIR

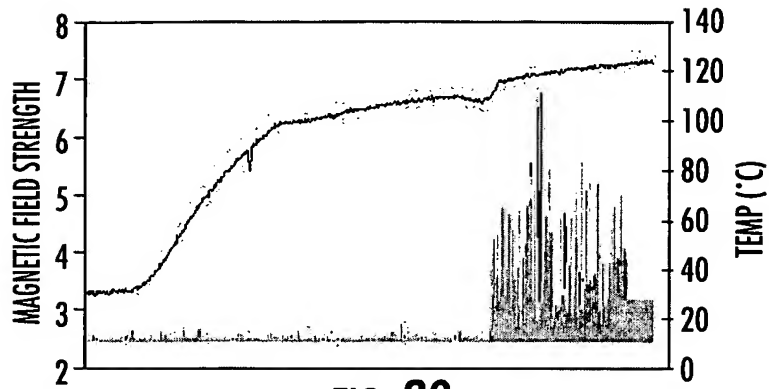


FIG. 20

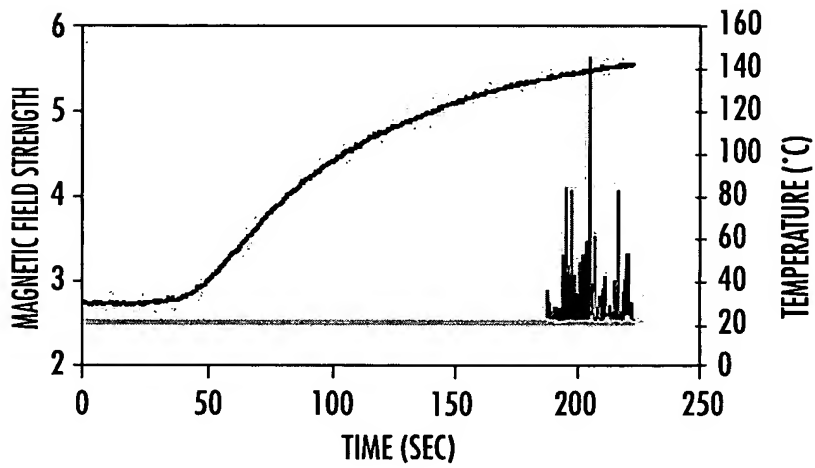


FIG. 21

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MAGNETIC PAIR + SINGLE MAGNET

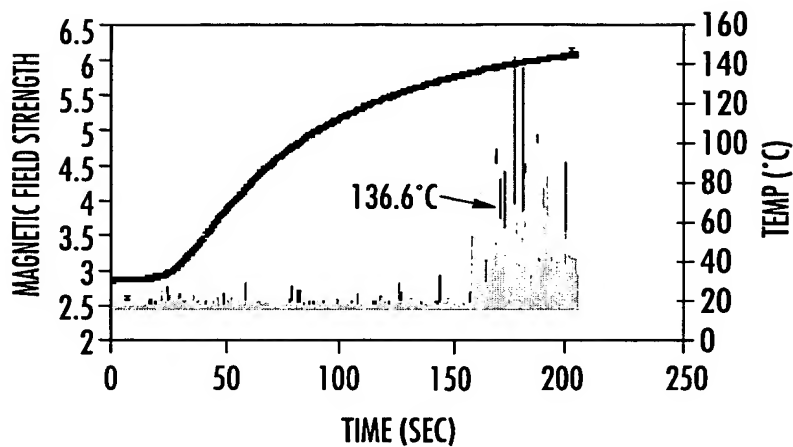


FIG. 22

SOLDER1 (MP = 138.3°C)

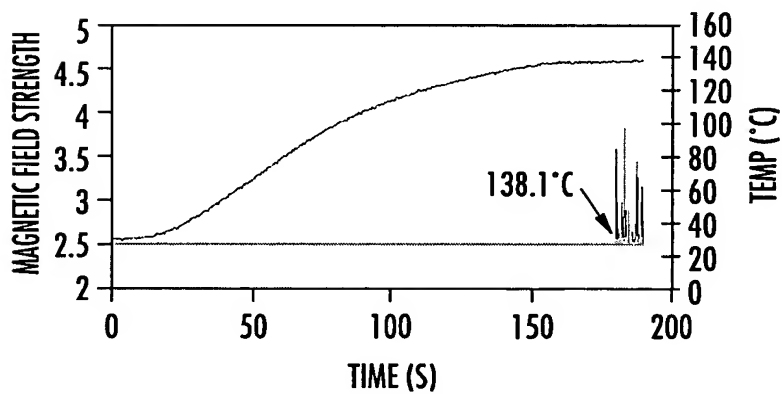


FIG. 23

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SOLDER1 (MP = 138.3°C)

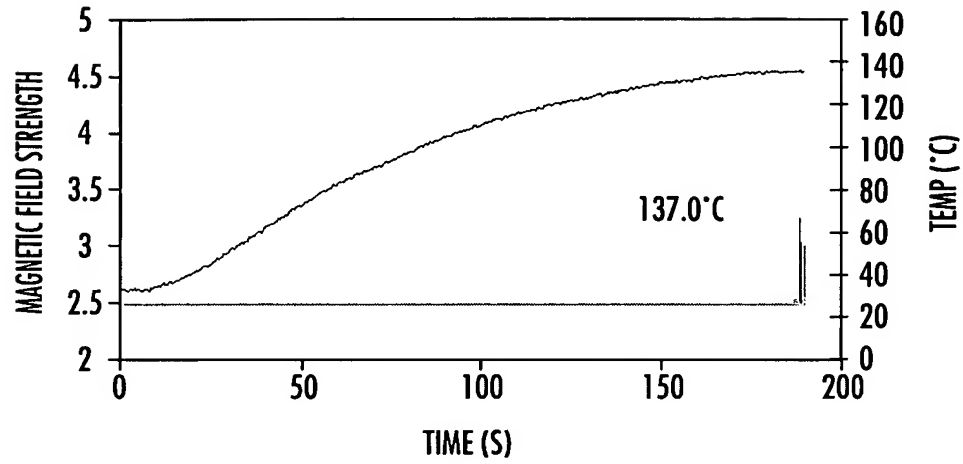


FIG. 24

SOLDER1 (MP = 138.3°C)

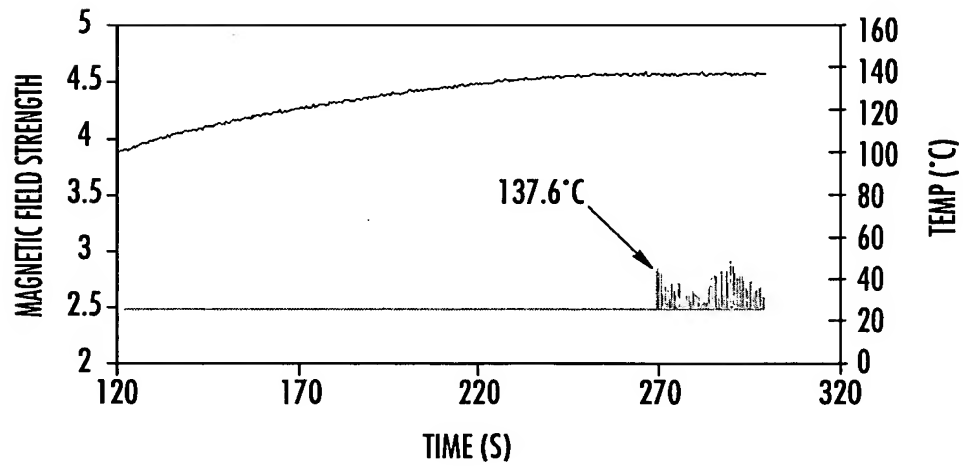


FIG. 25

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SOLDER1 (MP = 138.3°C)

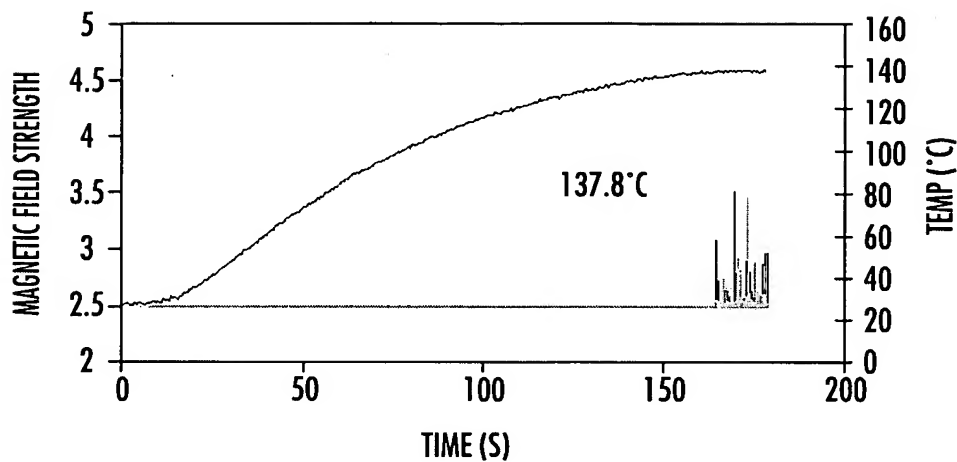


FIG. 26

SOLDER1 (MP = 138.3°C)

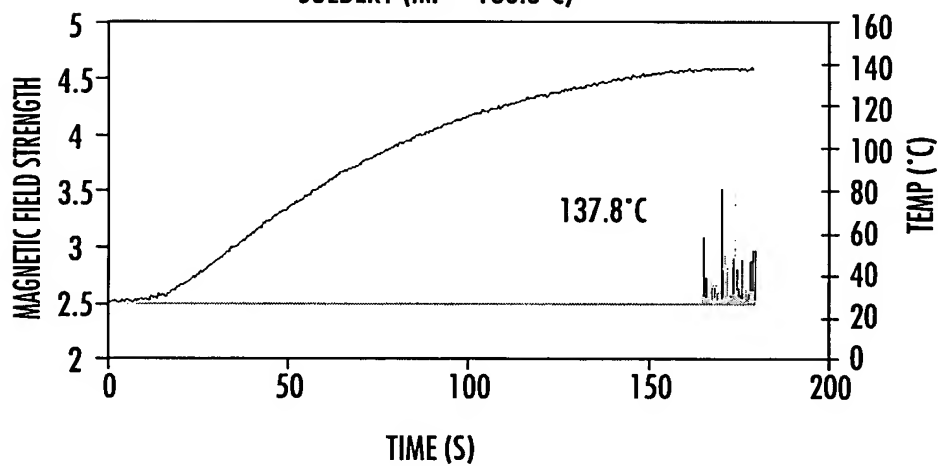


FIG. 27

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SOLDER2 (MP = 123.9°C)

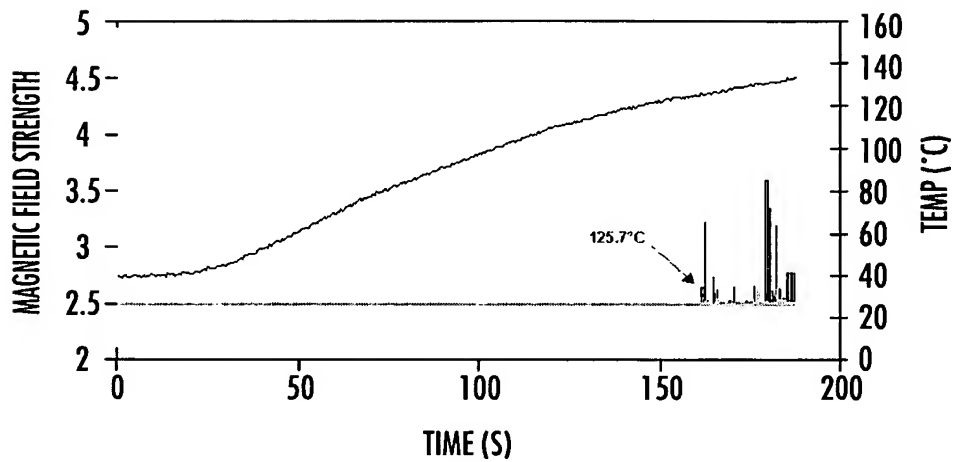


FIG. 28

SOLDER2 (MP = 123.9°C)

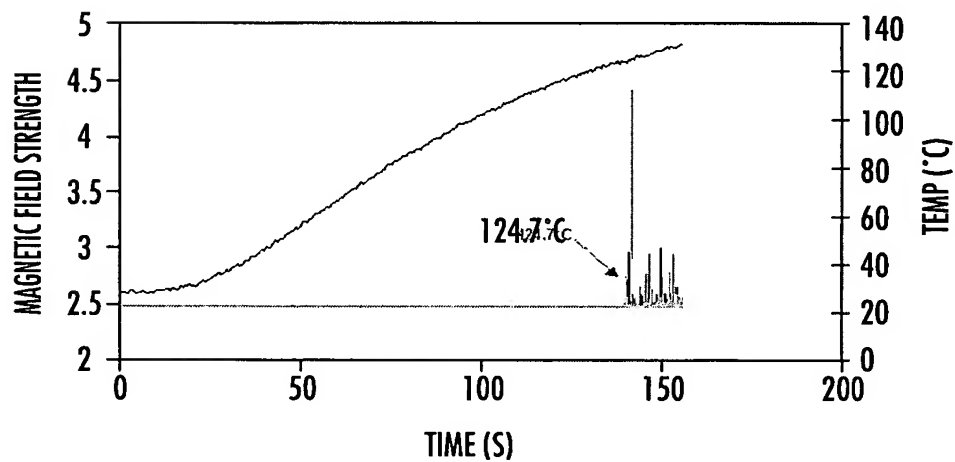


FIG. 29

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SOLDER2 (MP = 123.9°C)

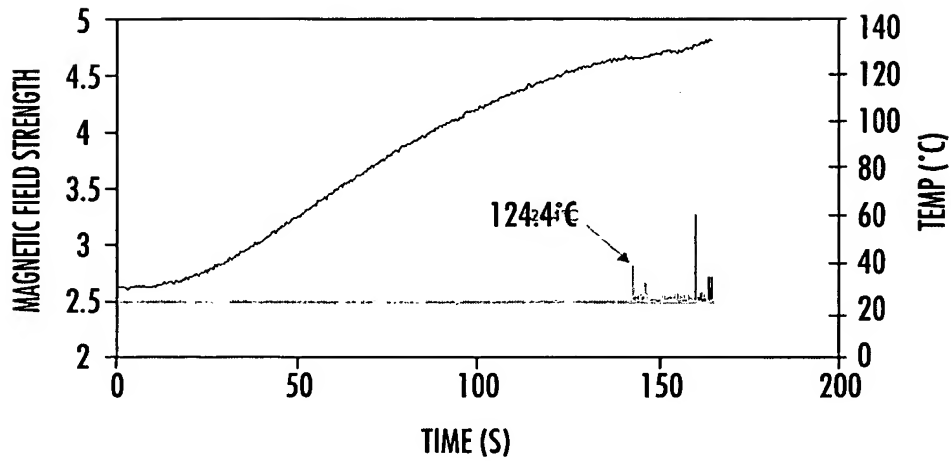


FIG. 30

135 C - TRIAL2

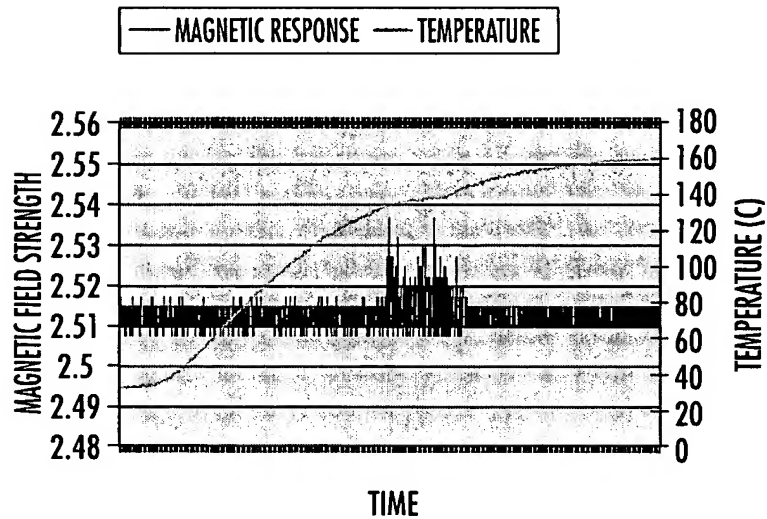


FIG. 31

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138 C - TRIAL1

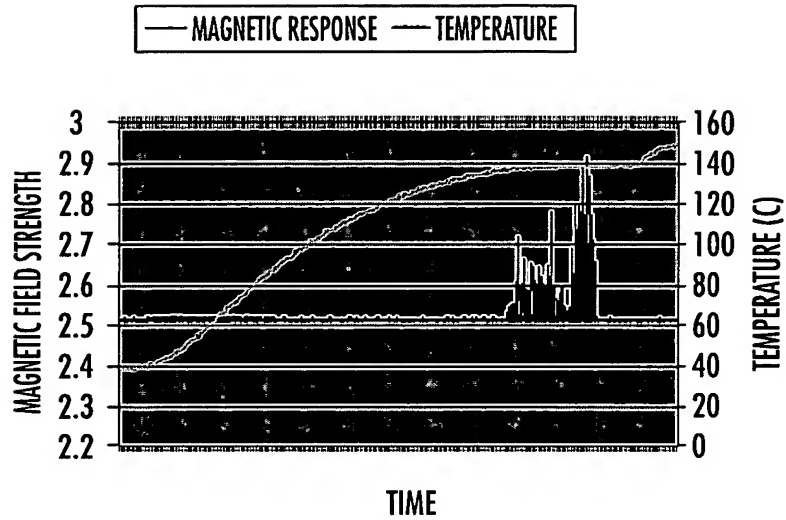


FIG. 32

DUAL TEMPERATURE DETECTION

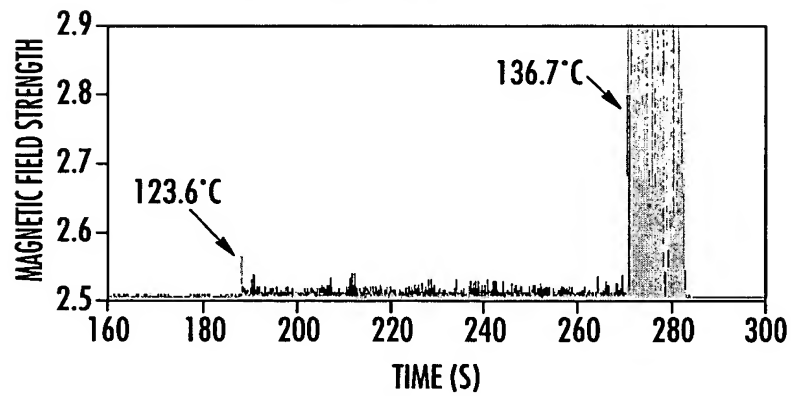
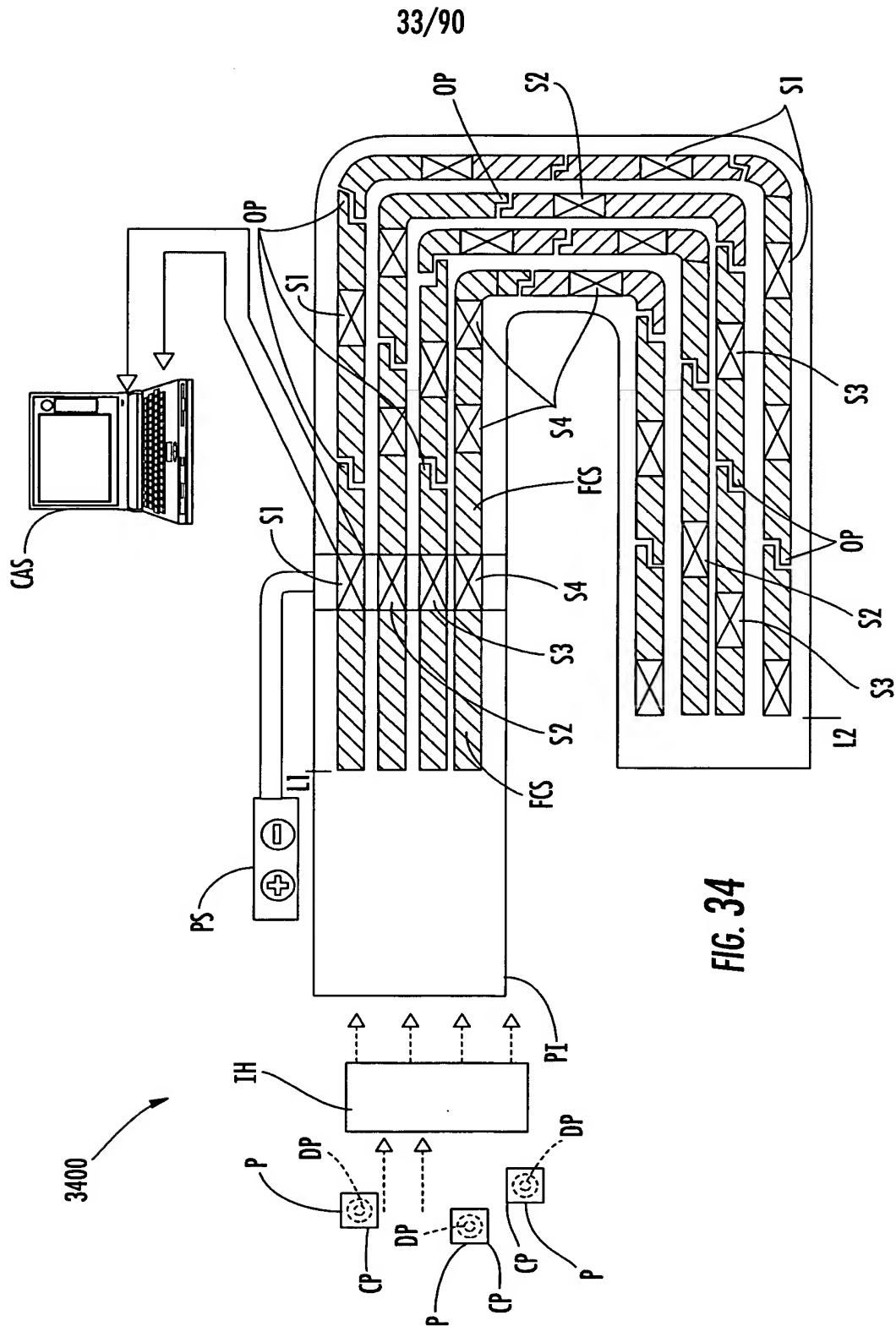


FIG. 33





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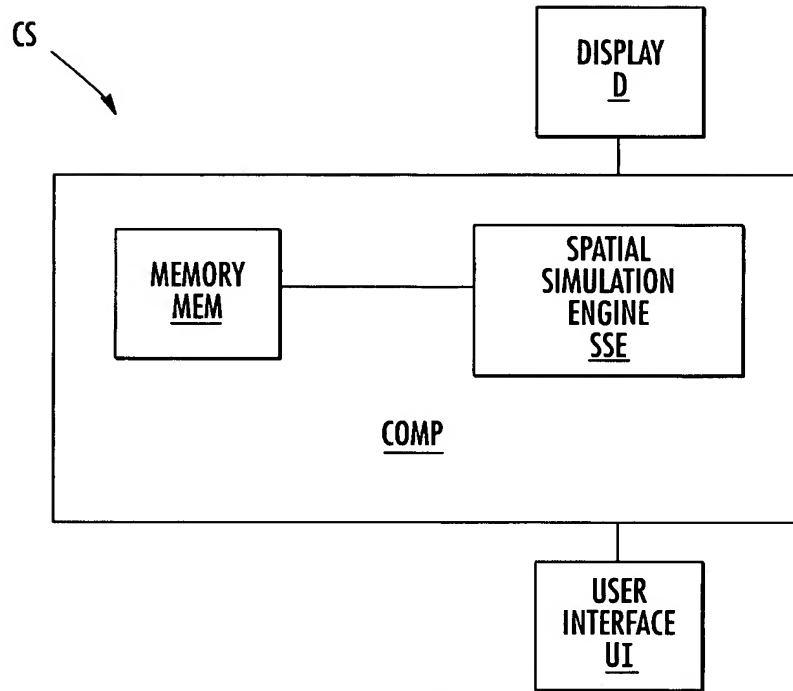
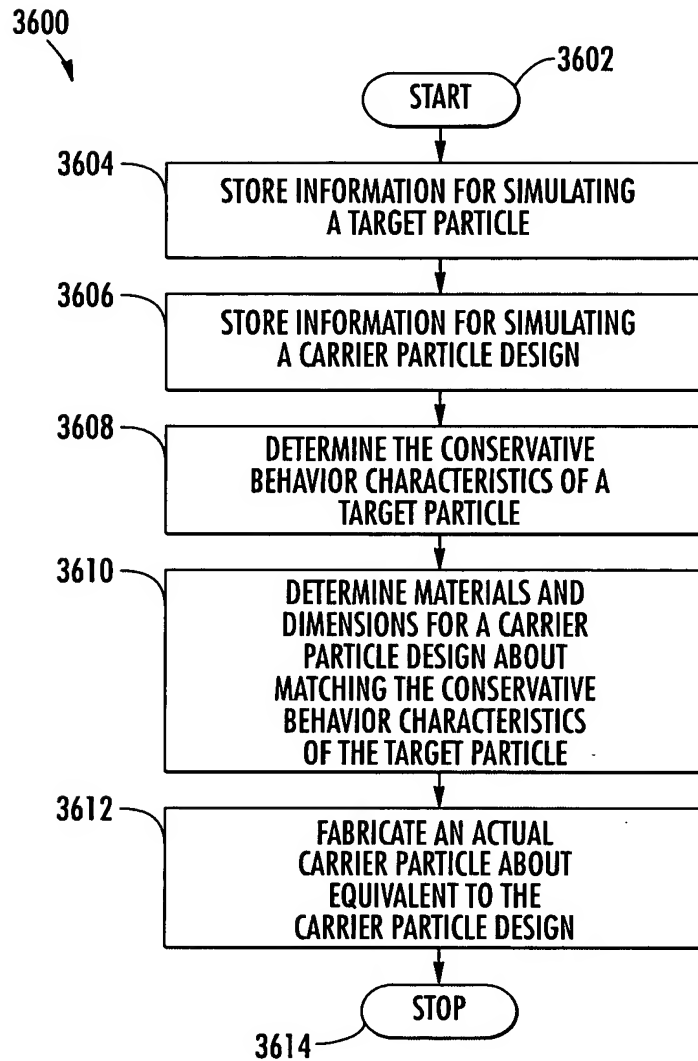


FIG. 35

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**FIG. 36**

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FIG. 37

**CUBIC PARTICLE**  
1/2 in.

**POLYPROPYLENE**  
 $F_0 = 3$  min

**3700**

**3702**

**POTATO**  
 $F_0 = 146$  min

MAPS® MULTIPHASE ASEPTIC PROCESSING SIMULATOR

PARTICLE: CUBIC

FLUID: DENSITY ( $\rho$  g/cc) 1000, SPECIFIC HEAT ( $\mu$  g/cc) 3500

PRODUCT: PARTICLE LOAD (% BY VOLUME) 30, FLOW RATE (L/h) 2, INITIAL TEMPERATURE (°C) 20

HEATING: HEATING TIME (SEC) 112, FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C) 140

HOLDING: REQUIRED HOLDING TIME 287.7 SEC, REQUIRED LENGTH OF HOLDING TUBE 55.3 in

COOLING: FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C) 140

THERMAL AND LETHALITY CREDIT: CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER, THERMAL CONTRIBUTION DURING HEATING, LETHALITY CONTRIBUTION DURING HEATING

OUTPUT: TIME-TEMP CURVE, LETHAL RATE CURVE, DISTRIBUTION

FO 146 min 12-D log reduction is reached

CENTER T (°C) 133.3, THAMINE RETENTION (%) 75.1, MASS AVERAGE T (°C) 142, LYSINE RETENTION (%) 82.3

OVERALL QUALITY RETENTION (%)

CARROTS 8.28e-21, POTATO 1.71e-11

SOLVE EXIT

FIG. 38

**CUBIC PARTICLE**  
3/8 in.

**POLYPROPYLENE**  
 $F_0 = 3$  min

**3800**

**3802**

**POTATO**  
 $F_0 = 93$  min

MAPS® MULTIPHASE ASEPTIC PROCESSING SIMULATOR

PARTICLE: CUBIC

FLUID: DENSITY ( $\rho$  g/cc) 1000, SPECIFIC HEAT ( $\mu$  g/cc) 3500

PRODUCT: PARTICLE LOAD (% BY VOLUME) 30, FLOW RATE (L/h) 2, INITIAL TEMPERATURE (°C) 20

HEATING: HEATING TIME (SEC) 112, FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C) 140

HOLDING: REQUIRED HOLDING TIME 174.4 SEC, REQUIRED LENGTH OF HOLDING TUBE 34.1 in

COOLING: FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C) 140

THERMAL AND LETHALITY CREDIT: CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER, THERMAL CONTRIBUTION DURING HEATING, LETHALITY CONTRIBUTION DURING HEATING

OUTPUT: TIME-TEMP CURVE, LETHAL RATE CURVE, DISTRIBUTION

FO 93 min 12-D log reduction is reached

CENTER T (°C) 133.3, THAMINE RETENTION (%) 75.1, MASS AVERAGE T (°C) 142, LYSINE RETENTION (%) 82.3

OVERALL QUALITY RETENTION (%)

CARROTS 4.58e-15, POTATO 2.25e-11

SOLVE EXIT

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FIG. 39

**CYLINDRICAL PARTICLE**  
 1/2 in. x 1/2 in.

**POLYPROPYLENE**  
 $F_0 = 3$  min

**3900**

**3902**

**POTATO**  
 $F_0 = 133$  min

FIG. 40

**CYLINDRICAL PARTICLE**  
 3/8 in. x 3/8 in.

**POLYPROPYLENE**  
 $F_0 = 3$  min

**4000**

**4002**

**POTATO**  
 $F_0 = 84$  min

38/90

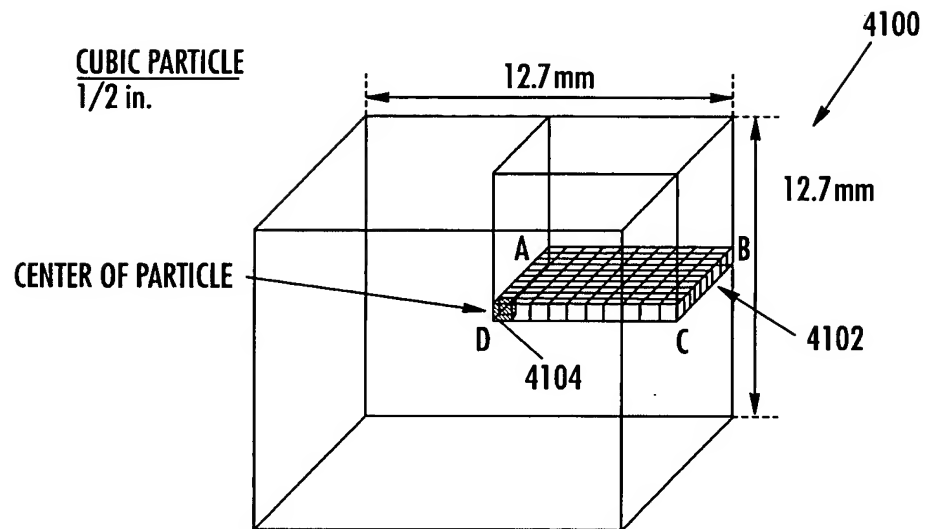


FIG. 41

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PARTICLE

CUBIC

FLUID

WATER

DENSITY (kg/m<sup>3</sup>) 1000

SPECIFIC HEAT (J/kg·K) 3600

HALF THICKNESS (m) 0.00635

DENSITY (kg/m<sup>3</sup>) 1020

K (W/m·K) 0.6

SPECIFIC HEAT (J/kg·K) 3600

HEATING

1000

HOLDING

140

COOLING

112

$t_{hp}$  (W/m<sup>2</sup>·K)

FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C)

☒ FLUID T INCREASES EXPONENTIALLY

☐ FLUID T INCREASES LINEARLY

THERMAL AND LETHALITY CREDIT

CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER  
☐ THERMAL CONTRIBUTION DURING HEATING  
☐ LETHALITY CONTRIBUTION DURING HEATING

OPTIONS

SPECIFY TARGET LETHALITY 1

TARGET LETHALITY 3 MIN

OUTPUT:

TIME-TEMP CURVE

NUTRIENT RETENTION

LETHAL RATE CURVE

DISTRIBUTION

DISTRIBUTION

REQUIRED HOLDING TIME 131.4 SEC

REQUIRED LENGTH OF HOLDING TUBE 259.3 m

CENTER T (°C) 131.9

MASS AVERAGE T (°C) 137.3

THIAMINE RETENTION (%) 93.4

LYSINE RETENTION (%) 98.3

OVERALL QUALITY RETENTION (%)

CARROTS 3.48E-01

POTATO 5.17E-01

LETHALITY (MIN)

131.4

DISTANCE FROM SURFACE (m)

259.3

CENTER  
 NODE 1  
 NODE 2  
 NODE 3  
 NODE 4  
 NODE 5  
 NODE 6  
 NODE 7  
 NODE 8  
 NODE 9  
 NODE 10

SURFACE  
 NODE 1  
 NODE 2  
 NODE 3  
 NODE 4  
 NODE 5  
 NODE 6  
 NODE 7  
 NODE 8  
 NODE 9  
 NODE 10

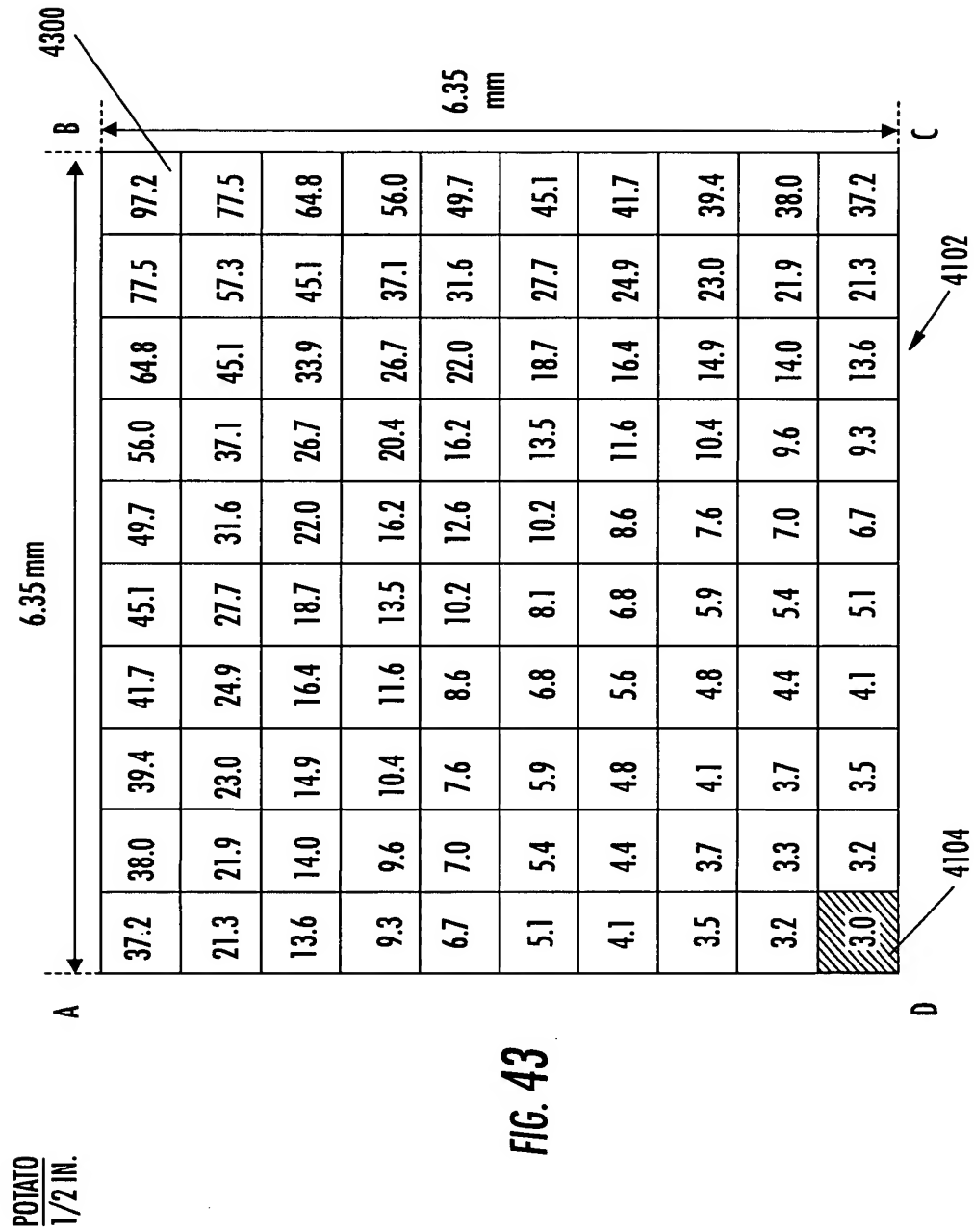
SOLVE

EXIT

**POTATO**  
**1/2 IN.**  
**F<sub>0</sub>(CENTER) = 3 MIN.**  
**TIME = 131.4 s**  
**(HOLDING ONLY)**  
 **$\alpha = 1.63 \times 10^{-7} \text{ m}^2/\text{s}$**

**FIG. 42**

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4400

MAPS® MULTIPHASE ASEPTIC PROCESSING SIMULATOR

PARTICLE		FLUID		HEATING		HOLDING		COOLING	
CUBIC		DENSITY (kg/m <sup>3</sup> )		h <sub>tp</sub> (W/m <sup>2</sup> -K)		FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C)		FLUID T INCREASES EXPONENTIALLY	
HALF THICKNESS (m)		SPECIFIC HEAT (J/kg-K)		HEATING TIME (SEC)		1000		FLUID T INCREASES LINEARLY	
0.00635		3600		112		1000		140	
PRODUCT		THERMAL AND LETHALITY CREDIT		CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER		SPECIFY HOLDING TIME		HOLDING TIME	
PARTICLE LOAD (% BY VOLUME)		30		<input type="checkbox"/> THERMAL CONTRIBUTION DURING HEATING <input type="checkbox"/> LETHALITY CONTRIBUTION DURING HEATING		1		131.4 SEC	
FLOW RATE (L/s)		2							
INITIAL TEMPERATURE (°C)		20							
LETHALITY(MIN)		DISTANCE FROM SURFACE (m)		TIME-TEMP CURVE		NUTRIENT RETENTION		LETHAL RATE CURVE	
10		10		Fo		.08 MIN		DISTRIBUTION	
CENTER		NODE 1		CENTER T (°C)		118		THIAMINE RETENTION (%)	
NODE 2		NODE 3		MASS AVERAGE T (°C)		133.8		LYSINE RETENTION (%)	
NODE 4		NODE 5		OVERALL QUALITY RETENTION (%)				94.5	
NODE 6		NODE 7		CARROTS		8.69E+00		POTATO	
NODE 8		NODE 9		7.11E+00					
NODE 10		SURFACE							

SOLVE EXIT

TPX  
 1/2 IN.  
 TIME = 131.4 s  
 (HOLDING ONLY)  
 $\alpha = 1.04 \times 10^{-7} \text{ m}^2/\text{s}$

FIG. 44

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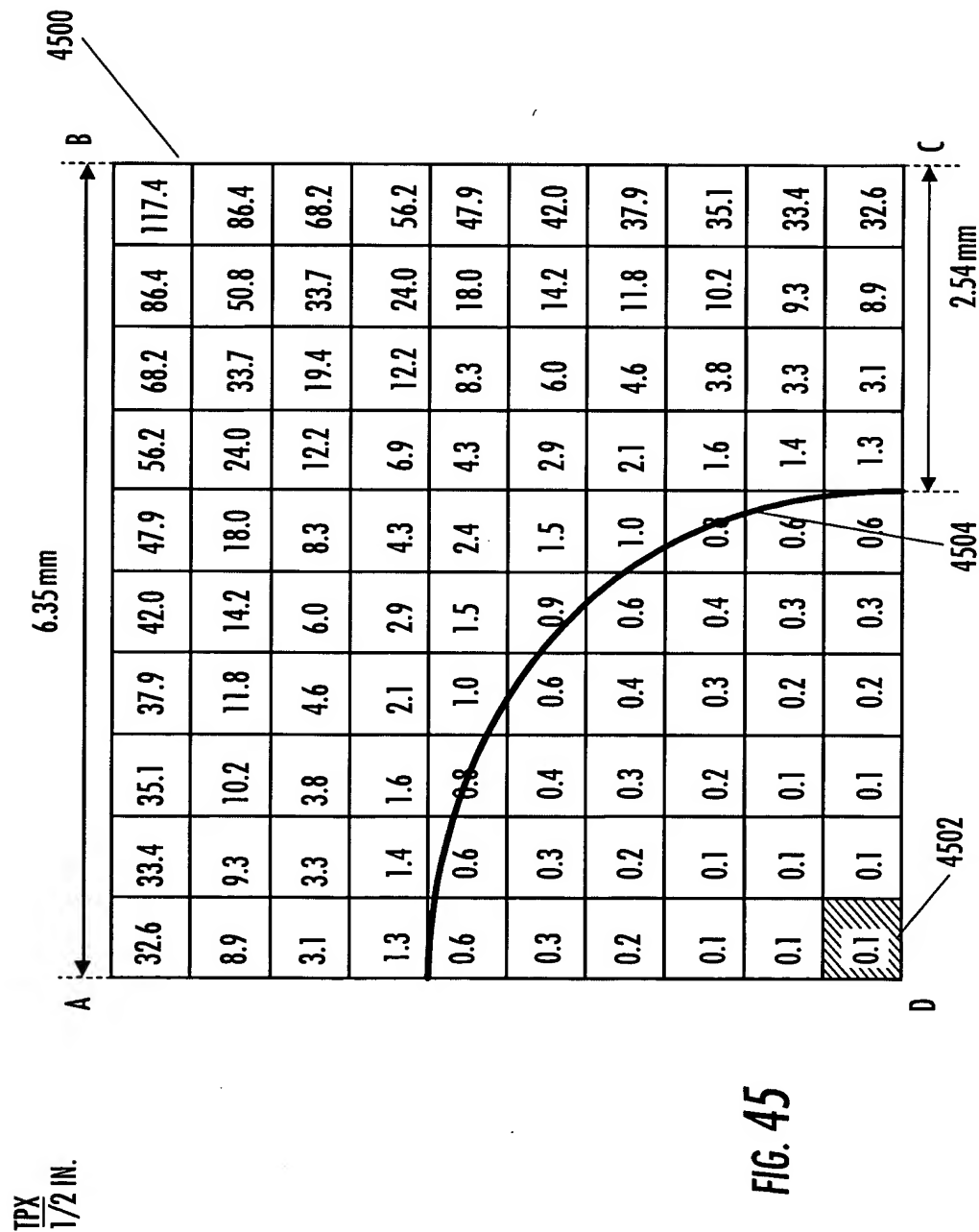


FIG. 45

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**MAPS® MULTIPHASE ASEPTIC PROCESSING SIMULATOR**

<b>PARTICLE</b> <input type="checkbox"/> CUBIC <input type="checkbox"/> SPHERICAL <input type="checkbox"/> CYLINDRICAL <input type="checkbox"/> OTHER		<b>FLUID</b> DENSITY (kg/m <sup>3</sup> ) <input type="text" value="1000"/> SPECIFIC HEAT (J/kg-K) <input type="text" value="3600"/>		<b>HEATING</b> h <sub>tp</sub> (W/m <sup>2</sup> -K) <input type="text" value="1000"/> HEATING TIME (SEC) <input type="text" value="112"/>		<b>HOLDING</b> FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C) <input type="text" value="140"/> <input checked="" type="radio"/> FLUID T INCREASES EXPONENTIALLY <input type="radio"/> FLUID T INCREASES LINEARLY		<b>COOLING</b>	
<b>PRODUCT</b> PARTICLE LOAD (% BY VOLUME) <input type="text" value="30"/> FLOW RATE (L/s) <input type="text" value="2"/> INITIAL TEMPERATURE (°C) <input type="text" value="20"/>		<b>LETHALITY (MIN)</b> <input type="text" value="0.00635"/> <b>DENSITY (kg/m<sup>3</sup>)</b> <input type="text" value="1120"/> <b>K (W/m-K)</b> <input type="text" value="0.24"/> <b>SPECIFIC HEAT (J/kg-K)</b> <input type="text" value="1527"/>		<b>THERMAL AND LETHALITY CREDIT</b> CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER <input type="checkbox"/> THERMAL CONTRIBUTION DURING HEATING <input type="checkbox"/> LETHALITY CONTRIBUTION DURING HEATING		<b>OPTIONS</b> SPECIFY HOLDING TIME <input type="text" value="1"/> HOLDING TIME <input type="text" value="131.4"/> SEC			

**OUTPUT:** ☐ TIME-TEMP CURVE ☐ NUTRIENT RETENTION ☐ LETHAL RATE CURVE ☐ DISTRIBUTION

Fo  MIN

CENTER T (°C)	<input type="text" value="130.2"/>	THIAMINE RETENTION (%)	<input type="text" value="92.9"/>
MASS AVERAGE T (°C)	<input type="text" value="137.1"/>	LYSINE RETENTION (%)	<input type="text" value="98.1"/>
OVERALL QUALITY RETENTION (%)			
CARROTS	<input type="text" value="6.93E-01"/>	POTATO	<input type="text" value="8.35E-01"/>

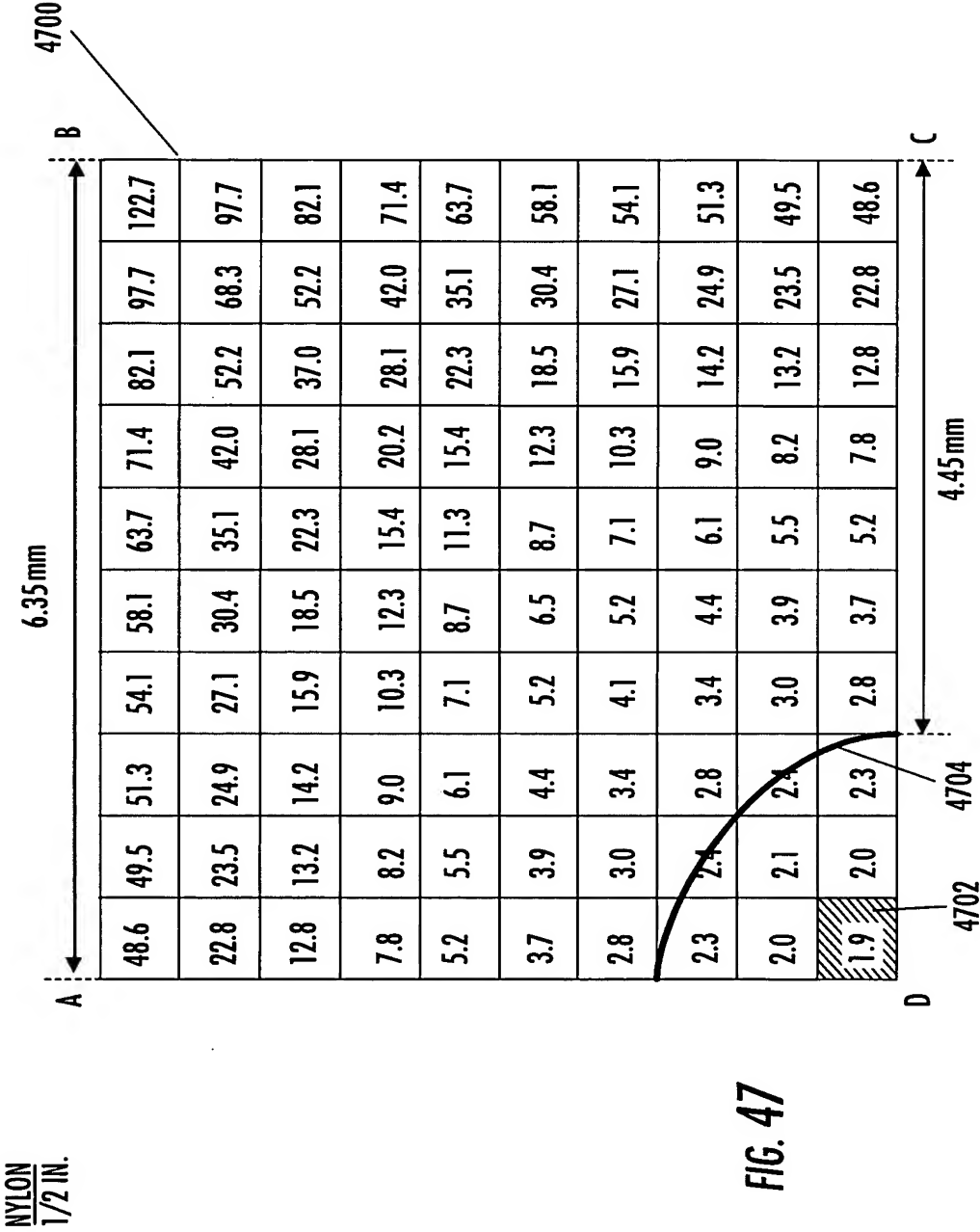
LETHALITY(MIN) DISTANCE FROM SURFACE (m)

CENTER NODE 1  
 NODE 2  
 NODE 3  
 NODE 4  
 NODE 5  
 NODE 6  
 NODE 7  
 NODE 8  
 NODE 9  
 SURFACE NODE 10

NYLON  
 1/2 IN.  
 TIME = 131.4 s  
 (HOLDING ONLY)  
 $\alpha = 1.40 \times 10^{-7} \text{ m}^2/\text{s}$

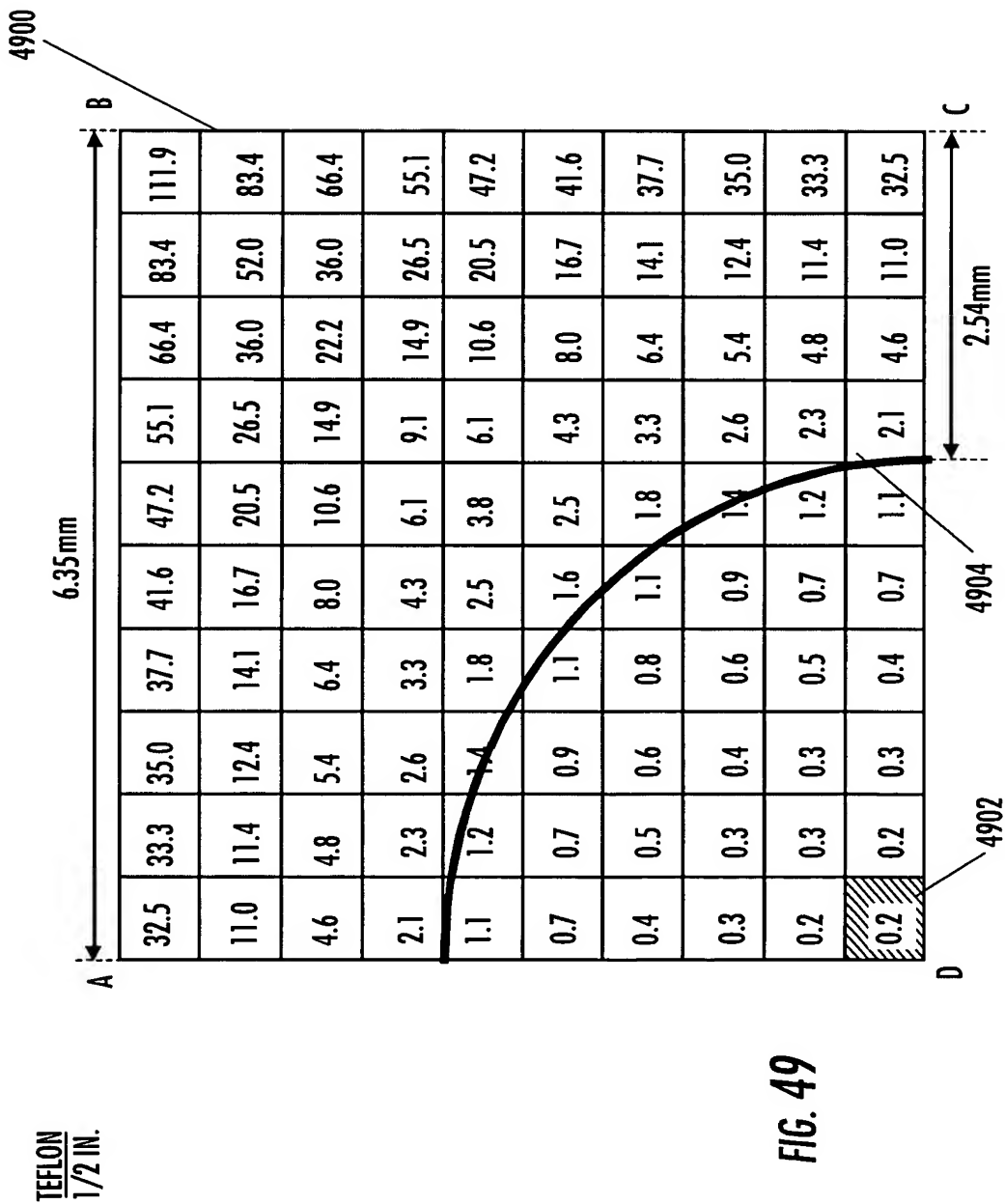
FIG. 46

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5000

MAPS® - MULTIPHASE ASEPTIC PROCESSING SIMULATOR

CUBIC HALF THICKNESS (m) 0.00635		FLUID DENSITY (kgm <sup>-3</sup> ) 1000 SPECIFIC HEAT (J/kg-K) 3600		HEATING h <sub>tp</sub> (W/m <sup>2</sup> -K) 1000 HEATING TIME (SEC) 112		HOLDING FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C) 140 <input checked="" type="radio"/> FLUID T INCREASES EXPONENTIALLY <input type="radio"/> FLUID T INCREASES LINEARLY		COOLING	
PRODUCT PARTICLE LOAD (% BY VOLUME) 30 FLOW RATE (J/s) 2 INITIAL TEMPERATURE (°C) 20		LETHALITY (MIN) 910 K (W/m-K) 0.13 SPECIFIC HEAT (J/kg-K) 2343		CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER <input type="checkbox"/> THERMAL CONTRIBUTION DURING HEATING <input type="checkbox"/> LETHALITY CONTRIBUTION DURING HEATING		OPTIONS SPECIFY HOLDING TIME 1 HOLDING TIME 131.4 SEC			

LETHALITY (MIN) 910 DISTANCE FROM SURFACE (m)

CENTER NODE 1  
 NODE 2  
 NODE 3  
 NODE 4  
 NODE 5  
 NODE 6  
 NODE 7  
 NODE 8  
 NODE 9  
 SURFACE NODE 10

OUTPUT: Fo MIN

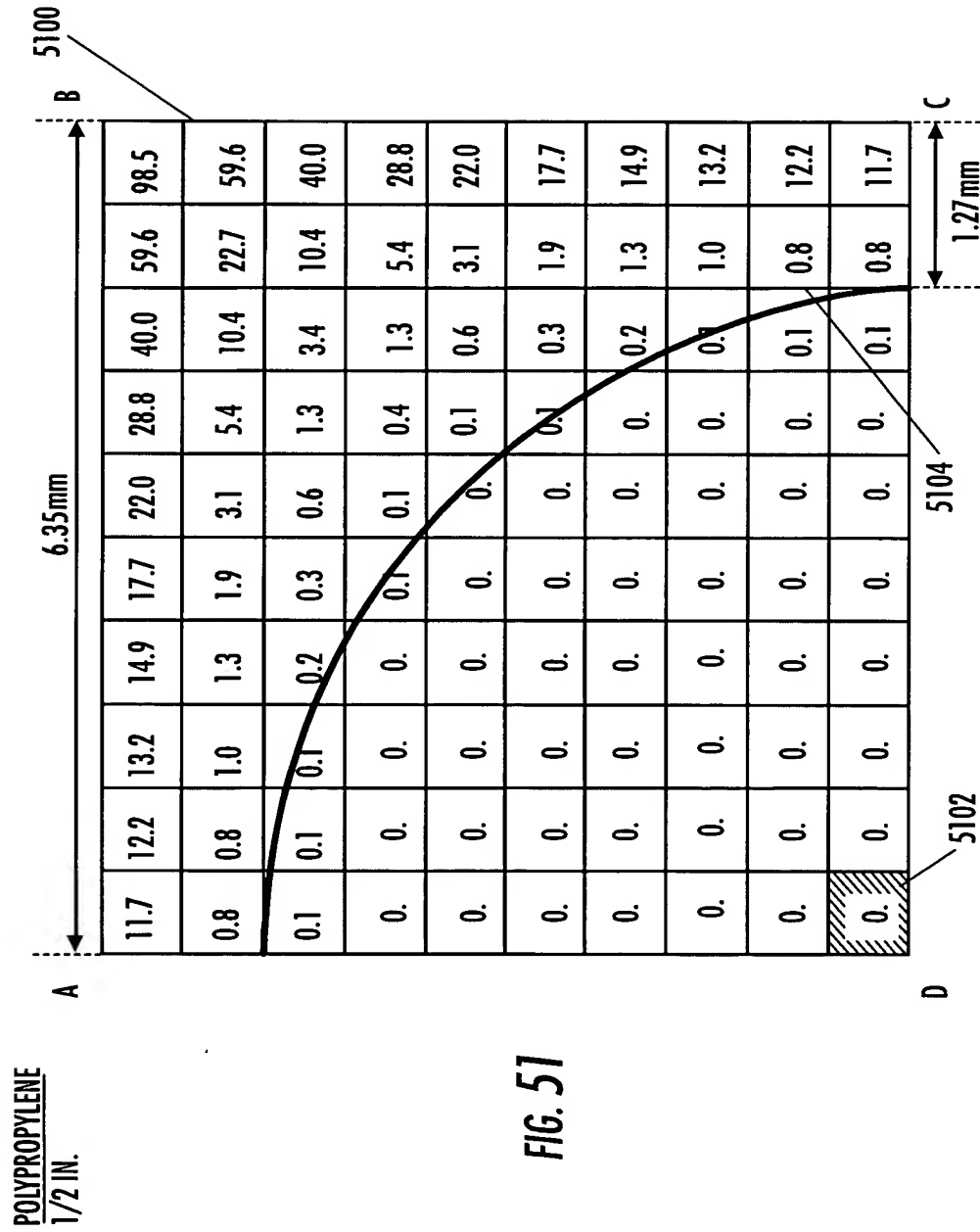
TIME-TEMP CURVE	NUTRIENT RETENTION	LETHAL RATE CURVE	DISTRIBUTION
CENTER T (°C) 82.3	THIAMINE RETENTION (%) 96.5		
MASS AVERAGE T (°C) 123.5	LYSINE RETENTION (%) 99.1		
OVERALL QUALITY RETENTION (%)			
CARROTS 3.48E+01	POTATO 3.02E+01		

SOLVE EXIT

POLYPROPYLENE  
 1/2 IN.  
 TIME = 131.4 s  
 (HOLDING ONLY)  
 $\alpha = 6.10 \times 10^{-8} \text{ m}^2/\text{s}$

FIG. 50

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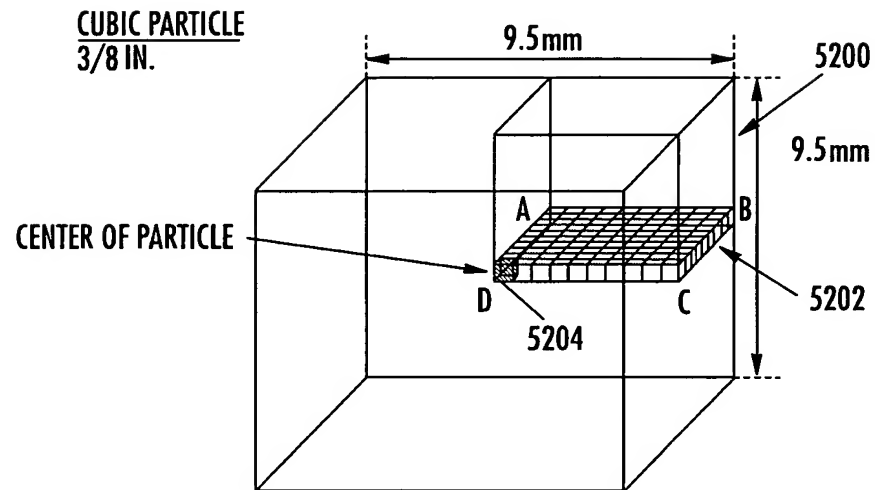




**REPLACEMENT DRAWING**

Title: Methods, Systems, and Devices  
for Evaluation of Thermal Treatment  
Inventors: Palazoglu et al.  
Attorney Docket No. 297/164/2

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**FIG. 52**

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**MAPS® - MULTIPHASE ASEPTIC PROCESSING SIMULATOR**

---

**PARTICLE**  
☐ CUBIC  
 HALF THICKNESS (m)

**FLUID**  
 DENSITY (kg/m<sup>3</sup>)   
 SPECIFIC HEAT (J/kg-K)

**PRODUCT**  
 PARTICLE LOAD (% BY VOLUME)   
 FLOW RATE (L/s)   
 INITIAL TEMPERATURE (°C)

---

**HEATING**  
 $h_{tp}$  (W/m<sup>2</sup>-K)   
 HEATING TIME (SEC)

**HOLDING**  
 FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C)   
☒ FLUID T INCREASES EXPONENTIALLY  
☐ FLUID T INCREASES LINEARLY

**COOLING**  
 SPECIFY TARGET LETHALITY

---

**THERMAL AND LETHALITY CREDIT**  
 CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER  
☐ THERMAL CONTRIBUTION DURING HEATING  
☐ LETHALITY CONTRIBUTION DURING HEATING

**OPTIONS**  
 TARGET LETHALITY  MIN

---

**OUTPUT:**  
 TIME-TEMP CURVE  
 NUTRIENT RETENTION  
 LETHAL RATE CURVE  
 DISTRIBUTION

REQUIRED HOLDING TIME  SEC  
 REQUIRED LENGTH OF HOLDING TUBE  m

---

CENTER T (°C)   
 MASS AVERAGE T (°C)   
 CARROTS

THIAMINE RETENTION (%)   
 LYSINE RETENTION (%)   
 POTATO

---

OVERALL QUALITY RETENTION (%)  
 CARROTS  POTATO

---

LETHALITY (MIN)  DISTANCE FROM SURFACE (m)

---

CENTER  
 NODE 1  
 NODE 2  
 NODE 3  
 NODE 4  
 NODE 5  
 NODE 6  
 NODE 7  
 NODE 8  
 NODE 9  
 NODE 10

SURFACE  
 NODE 10

---

POTATO

3/8 IN.

F<sub>0</sub>(CENTER) = 3 MIN.

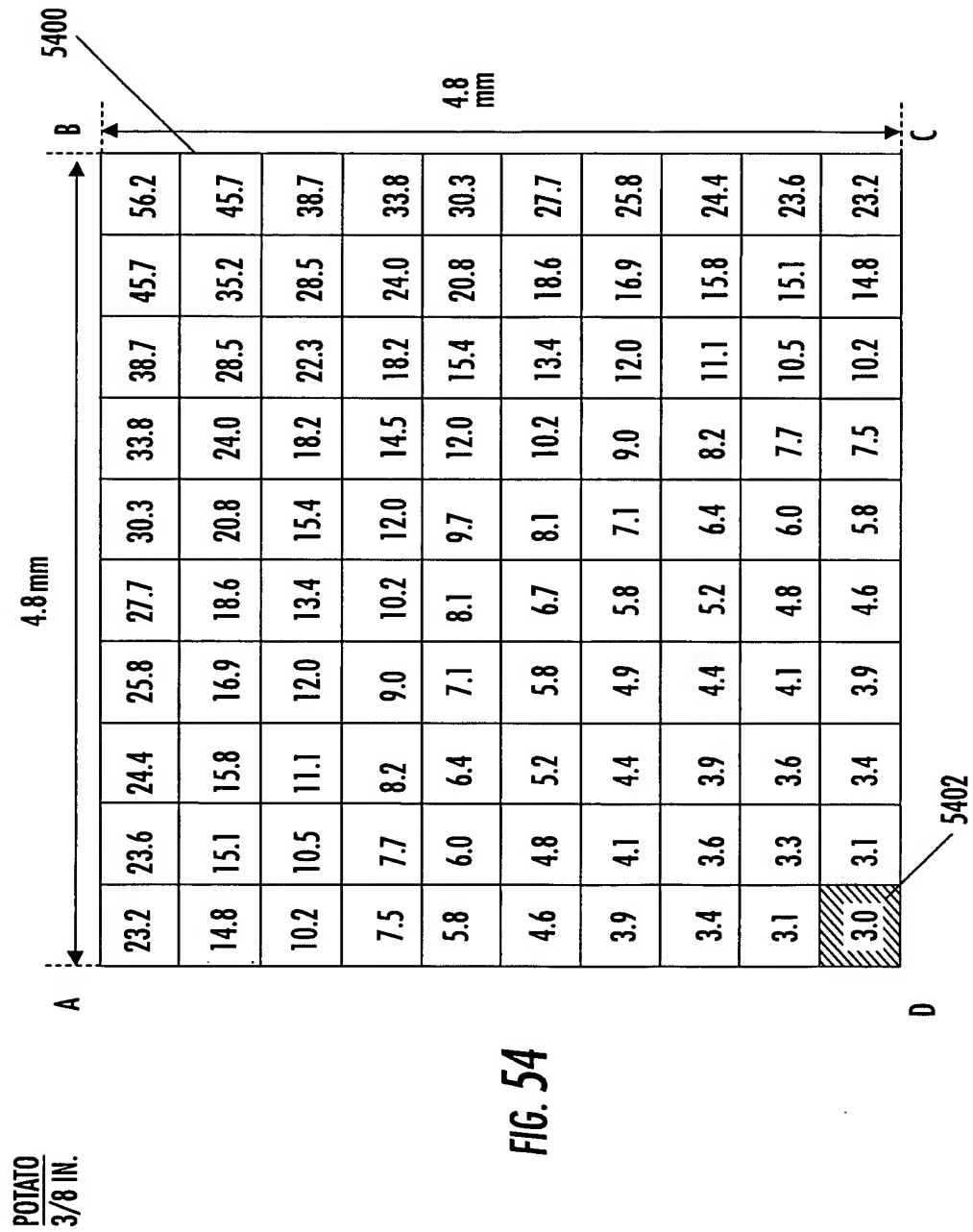
TIME = 82.1 s

(HOLDING ONLY)

 $\alpha = 1.63 \times 10^{-7} \text{ m}^2/\text{s}$ 

FIG. 53

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MAPS® - MULTIPHASE ASEPTIC PROCESSING SIMULATOR

<b>PARTICLE</b> <input type="checkbox"/> CUBIC <input type="checkbox"/> SPHERICAL <input type="checkbox"/> CYLINDRICAL <input type="checkbox"/> OTHER		<b>FLUID</b> DENSITY (kg/m <sup>3</sup> ) <input type="text" value="1000"/> SPECIFIC HEAT (J/kg-K) <input type="text" value="3600"/>		<b>HEATING</b> h <sub>tp</sub> (W/m <sup>2</sup> -K) <input type="text" value="1000"/> HEATING TIME (SEC) <input type="text" value="112"/>		<b>HOLDING</b> FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C) <input type="text" value="140"/> <input checked="" type="radio"/> FLUID T INCREASES EXPONENTIALLY <input type="radio"/> FLUID T INCREASES LINEARLY		<b>COOLING</b>	
<b>PRODUCT</b> HALF THICKNESS (m) <input type="text" value="0.0048"/> DENSITY (kg/m <sup>3</sup> ) <input type="text" value="833"/> K (W/m-K) <input type="text" value="0.17"/> SPECIFIC HEAT (J/kg-K) <input type="text" value="1958"/>		PARTICLE LOAD (% BY VOLUME) <input type="text" value="30"/> FLOW RATE (L/s) <input type="text" value="2"/> INITIAL TEMPERATURE (°C) <input type="text" value="20"/>		<b>THERMAL AND LETHALITY CREDIT</b> CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER <input type="checkbox"/> THERMAL CONTRIBUTION DURING HEATING <input type="checkbox"/> LETHALITY CONTRIBUTION DURING HEATING		<b>OPTIONS</b> SPECIFY HOLDING TIME <input type="text" value="82.1"/> SEC HOLDING TIME <input type="text" value="82.1"/> SEC			

LETHALITY (MIN)  DISTANCE FROM SURFACE (m)

CENTER NODE 1  
 NODE 2  
 NODE 3  
 NODE 4  
 NODE 5  
 NODE 6  
 NODE 7  
 NODE 8  
 NODE 9  
 SURFACE NODE 10

SOLVE  
 EXIT

OUTPUT:  
 TIME-TEMP CURVE  
 NUTRIENT RETENTION  
 LETHAL RATE CURVE  
 DISTRIBUTION

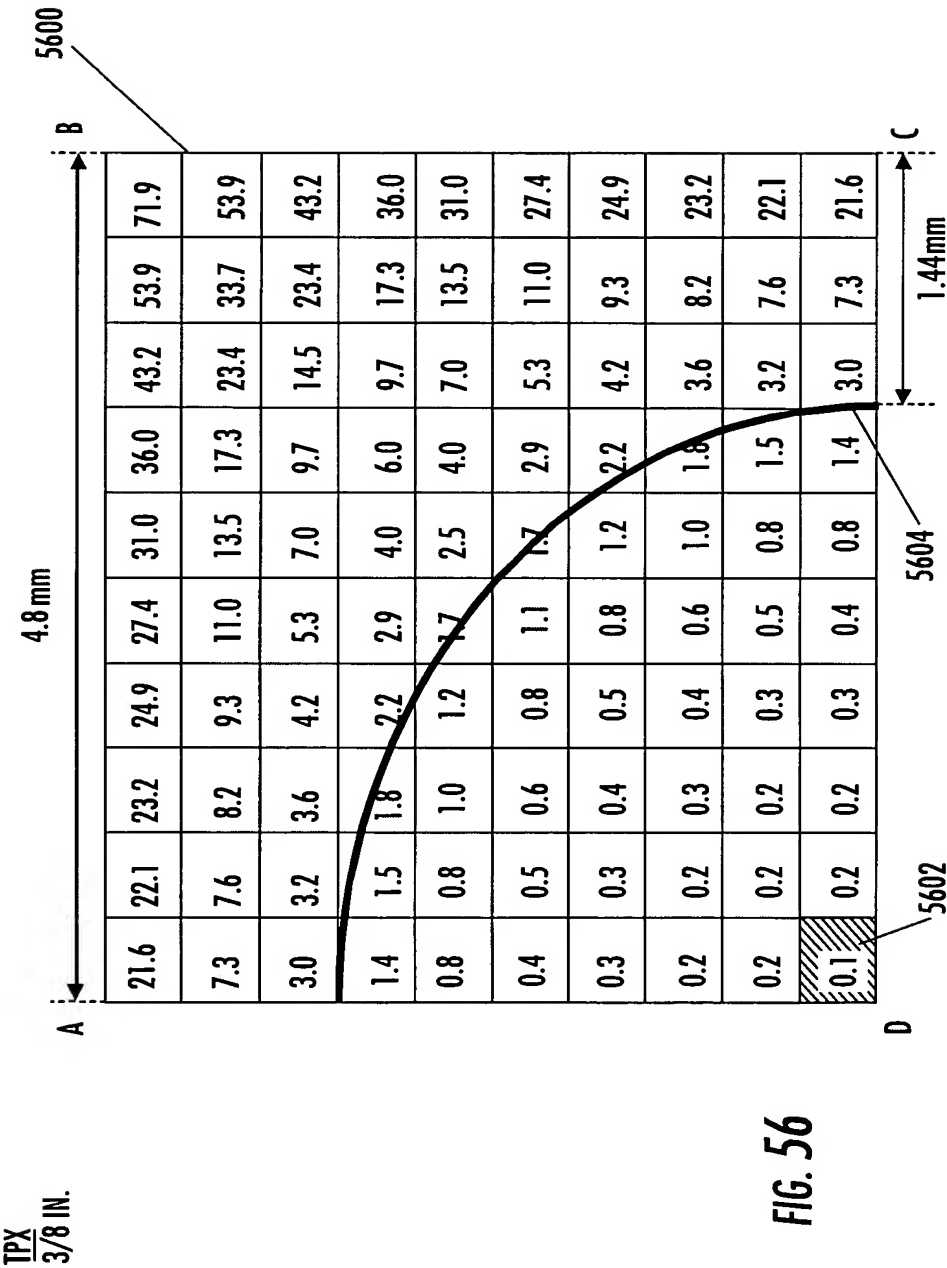
Fo  MIN

CENTER T (°C)	122.4	THIAMINE RETENTION (%)	96.3
MASS AVERAGE T (°C)	134.9	LYSINE RETENTION (%)	99
CARROTS	9.38E+00	POTATO	8.91E+00
OVERALL QUALITY RETENTION (%)			

TPX  
 3/8 IN.  
 TIME = 82.1 s  
 (HOLDING ONLY)  
 $\alpha = 1.04 \times 10^{-7} \text{ m}^2/\text{s}$

FIG. 55

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MAPS® MULTIPHASE ASEPTIC PROCESSING SIMULATOR

**PARTICLE**  
CUBIC  
HALF THICKNESS (m) 0.0048  
DENSITY (kg/m<sup>3</sup>) 1120  
K (W/m·K) 0.24  
SPECIFIC HEAT (J/kg·K) 1527

**FLUID**  
DENSITY (kg/m<sup>3</sup>) 1000  
SPECIFIC HEAT (J/kg·K) 3600  
PRODUCT  
PARTICLE LOAD (% BY VOLUME) 30  
FLOW RATE (L/s) 2  
INITIAL TEMPERATURE (°C) 20

**HEATING**  
h<sub>tp</sub> (W/m<sup>2</sup>·K) 1000  
HEATING TIME (SEC) 112  
THERMAL AND LETHALITY CREDIT  
CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR  
LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER  
☐ THERMAL CONTRIBUTION DURING HEATING  
☐ LETHALITY CONTRIBUTION DURING HEATING

**HOLDING**  
FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C) 140  
☒ FLUID T INCREASES EXPONENTIALLY  
☐ FLUID T INCREASES LINEARLY

**COOLING**  
SPECIFY HOLDING TIME 1  
HOLDING TIME 82.1 SEC

**OUTPUT:**  
TIME-TEMP CURVE  
LETHAL RATE CURVE  
DISTRIBUTION

F<sub>0</sub> 2.35 MIN

CENTER T (°C) 132.6  
MASS AVERAGE T (°C) 137.8  
THIAMINE RETENTION (%) 95.3  
LYSINE RETENTION (%) 98.8  
OVERALL QUALITY RETENTION (%)  
CARROTS 1.02E+00  
POTATO 1.63E+00

LETHALITY(MIN) DISTANCE FROM SURFACE (m)

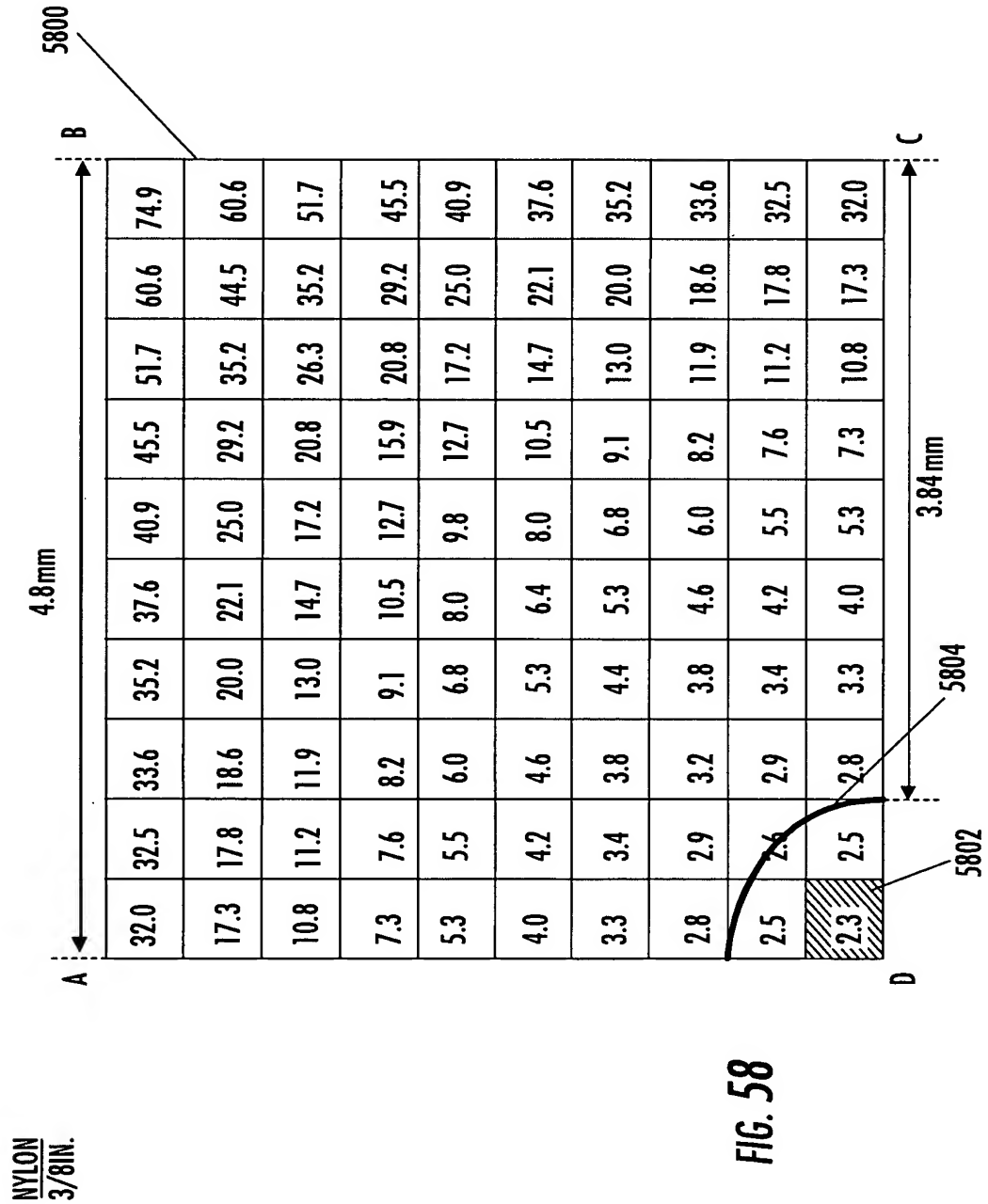
CENTER  
NODE 1  
NODE 2  
NODE 3  
NODE 4  
NODE 5  
NODE 6  
NODE 7  
NODE 8  
NODE 9  
NODE 10

SURFACE  
SOLVE  
EXIT

NYLON  
3/8 IN.  
TIME = 82.1 s  
(HOLDING ONLY)  
 $\alpha = 1.40 \times 10^{-7} \text{ m}^2/\text{s}$

FIG. 57

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5900

MAPS® MULTIPHASE ASEPTIC PROCESSING SIMULATOR

<b>PARTICLE</b> CUBIC HALF THICKNESS (m) 0.0048		<b>FLUID</b> DENSITY (kgm <sup>-3</sup> ) 1000 SPECIFIC HEAT (J/kg-K) 3600		<b>HEATING</b> h <sub>tp</sub> (W/m <sup>2</sup> -K) 1000 HEATING TIME (SEC) 112		<b>HOLDING</b> FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C) 140 <input checked="" type="radio"/> FLUID T INCREASES EXPONENTIALLY <input type="radio"/> FLUID T INCREASES LINEARLY		<b>COOLING</b>	
<b>PRODUCT</b> PARTICLE LOAD (% BY VOLUME) 30 FLOW RATE (L/s) 2 INITIAL TEMPERATURE (°C) 20		<b>OPTIONS</b> THERMAL AND LETHALITY CREDIT CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER <input type="checkbox"/> THERMAL CONTRIBUTION DURING HEATING <input type="checkbox"/> LETHALITY CONTRIBUTION DURING HEATING SPECIFY HOLDING TIME 1 HOLDING TIME 82.1 SEC							

LETHALITY(MIN) DISTANCE FROM SURFACE (m)

CENTER	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE 10
SURFACE										

OUTPUT: TIME-TEMP CURVE LETHAL RATE CURVE DISTRIBUTION

Fo 34 MIN

CENTER T (°C)	125.6	THIAMINE RETENTION (%)	96.2
MASS AVERAGE T (°C)	135.7	LYSINE RETENTION (%)	99
OVERALL QUALITY RETENTION (%)			
CARROTS	6.41E+00	POTATO	6.49E+00

SOLVE EXIT

TEFLON  
 3/8 IN.  
 TIME = 82.1 s  
 (HOLDING ONLY)  
 $\alpha = 1.15 \times 10^{-7} \text{ m}^2/\text{s}$

FIG. 59



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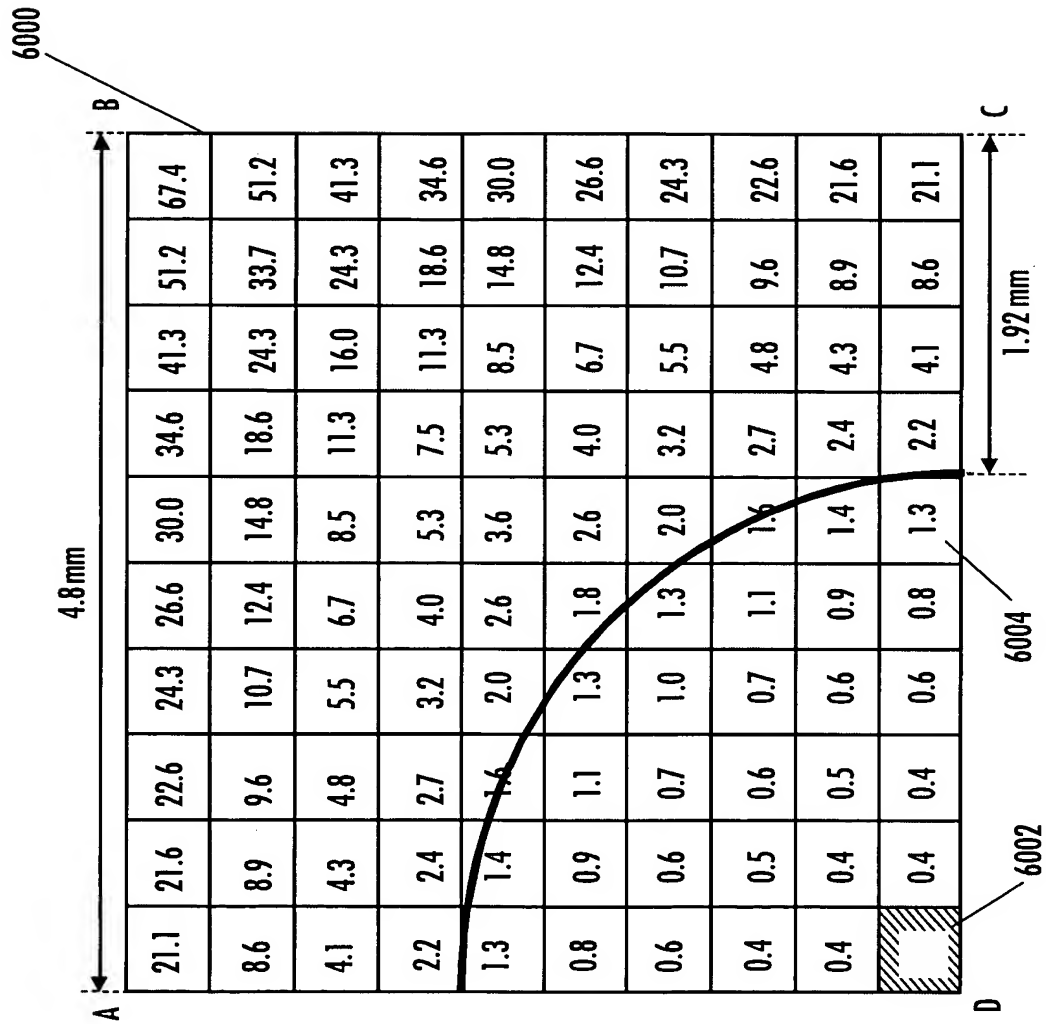


FIG. 60

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6100

MAPS® MULTIPHASE ASEPTIC PROCESSING SIMULATOR

PARTICLE

CUBIC

HALF THICKNESS (m)

0.0048

DENSITY (kgm<sup>-3</sup>)

910

K (W/m-K)

0.13

SPECIFIC HEAT (J/kg-K)

2343

FLUID

DENSITY (kgm<sup>-3</sup>)

1000

SPECIFIC HEAT (J/kg-K)

3600

PRODUCT

PARTICLE LOAD (% BY VOLUME)

30

FLOW RATE (L/s)

2

INITIAL TEMPERATURE (°C)

20

HEATING

$h_{tp}$  (W/m<sup>2</sup>-K)

1000

HEATING TIME (SEC)

112

HOLDING

FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C)

140

FLUID T INCREASES EXPONENTIALLY

FLUID T INCREASES LINEARLY

COOLING

FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C)

140

FLUID T INCREASES EXPONENTIALLY

FLUID T INCREASES LINEARLY

OPTIONS

THERMAL AND LETHALITY CREDIT

CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER

THERMAL CONTRIBUTION DURING HEATING

LETHALITY CONTRIBUTION DURING HEATING

SPECIFY HOLDING TIME

82.1 SEC

OUTPUT

TIME-TEMP CURVE

NUTRIENT RETENTION

LETHAL RATE CURVE

DISTRIBUTION

Fo

MIN

CENTER T (°C)

88.9

THIAMINE RETENTION (%)

97.7

MASS AVERAGE T (°C)

125.2

LYSINE RETENTION (%)

99.4

OVERALL QUALITY RETENTION (%)

CARROTS

3.70E-01

POTATO

3.34E-01

CENTER

NODE 1

NODE 2

NODE 3

NODE 4

NODE 5

NODE 6

NODE 7

NODE 8

NODE 9

NODE 10

SURFACE

LETHALITY(MIN)

DISTANCE FROM SURFACE (m)

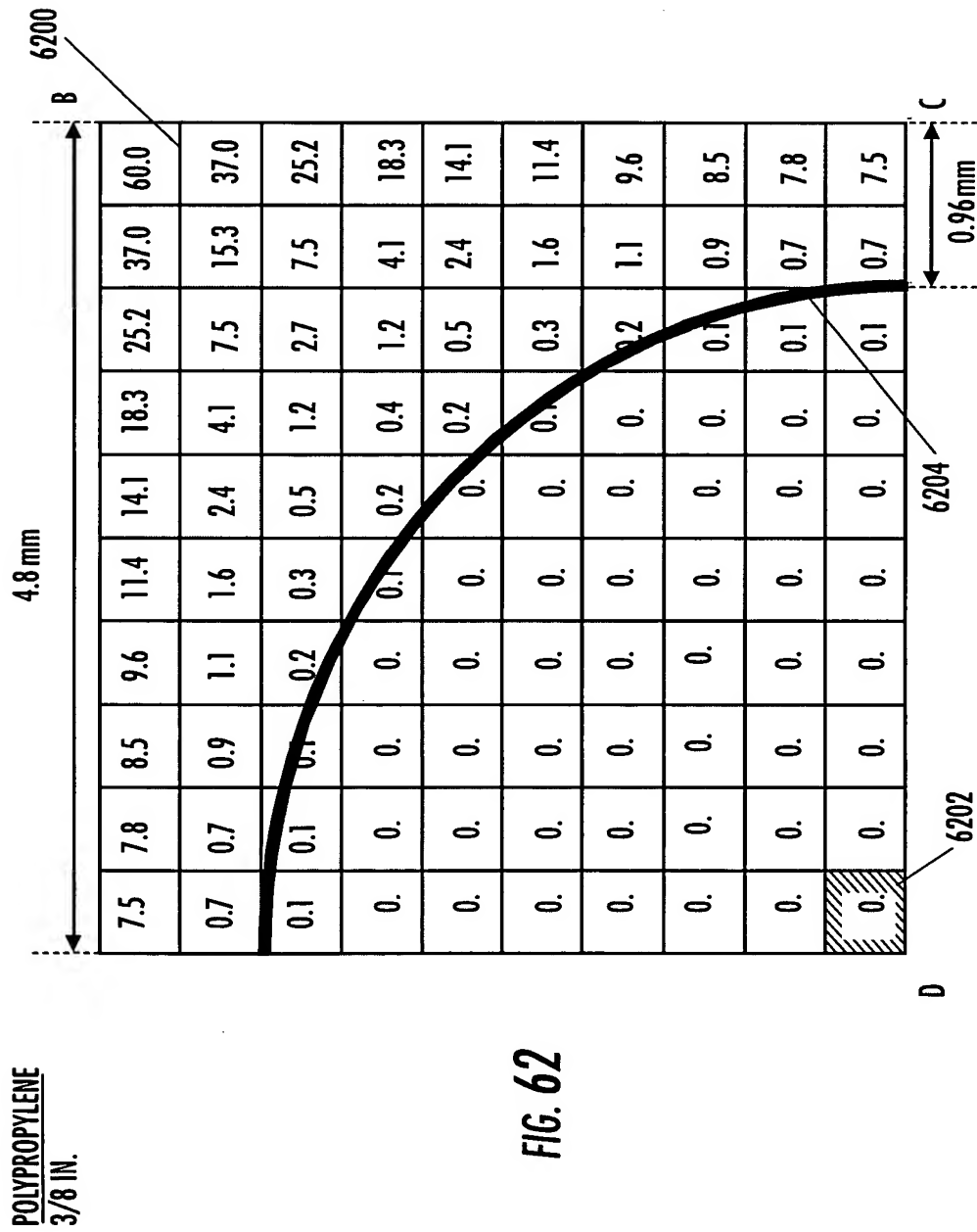
SOLVE

EXIT

POLYPROPYLENE  
3/8 IN.  
TIME = 82.1  
(HOLDING ONLY)  
 $\alpha = 6.10 \times 10^{-8} \text{m}^2/\text{s}$

FIG. 61

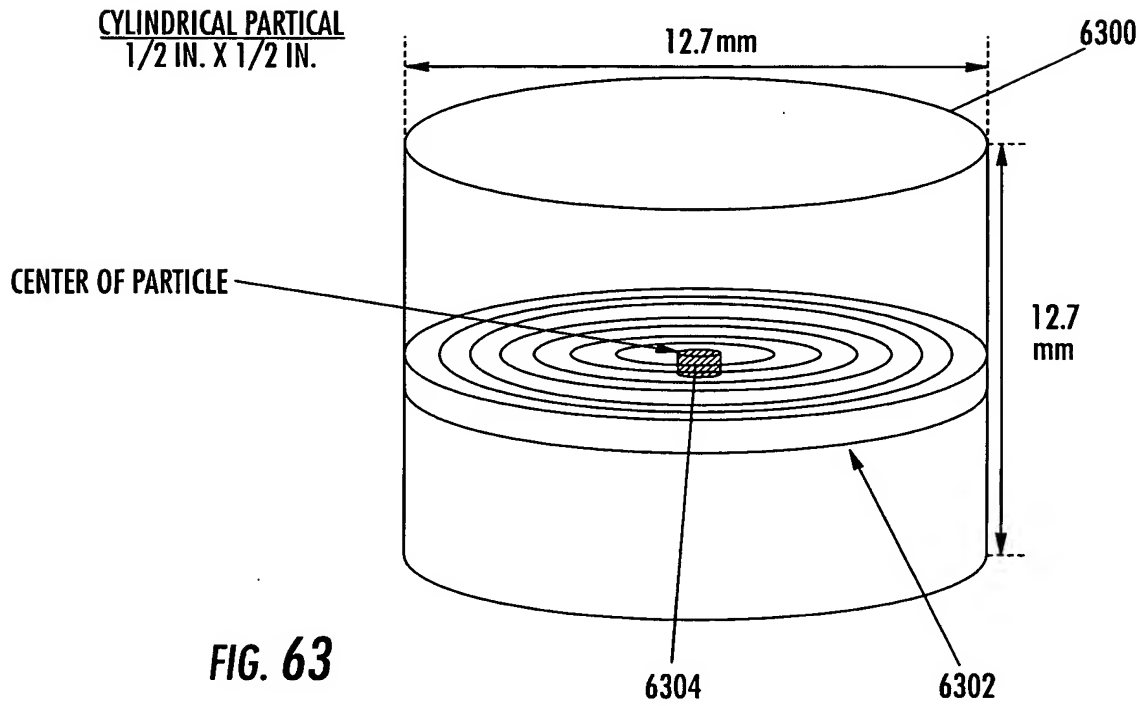
59/90



**REPLACEMENT DRAWING**

Title: Methods, Systems, and Devices  
for Evaluation of Thermal Treatment  
Inventors: Palazoglu et al.  
Attorney Docket No. 297/164/2

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# REPLACEMENT DRAWING

Title: Methods, Systems, and Devices  
for Evaluation of Thermal Treatment  
Inventors: Palazoglu et al.  
Attorney Docket No. 297/164/2

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6400

**MAPS® - MULTIPHASE ASEPTIC PROCESSING SIMULATOR**

PARTICLE		FLUID		HEATING		HOLDING		COOLING	
[CYLINDRICAL]		DENSITY (kg/m³)	1000	$h_{tp}$ (W/m²·K)	1000	FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C)		140	
RADIUS (m)	0.00635	SPECIFIC HEAT (J/kg·K)	3600	HEATING TIME (SEC)		112	<input checked="" type="radio"/> FLUID T INCREASES EXPONENTIALLY <input type="radio"/> FLUID T INCREASES LINEARLY		
HALF THICKNESS (m)	0.00635	PRODUCT		OPTIONS					
DENSITY (kg/m³)	1020	PARTICLE LOAD (% BY VOLUME)	30	THERMAL AND LETHALITY CREDIT					
K (W/m·K)	0.6	FLOW RATE (L/s)	2	CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER					
SPECIFIC HEAT (J/kg·K)	3600	INITIAL TEMPERATURE (°C)	20	<input type="checkbox"/> THERMAL CONTRIBUTION DURING HEATING <input type="checkbox"/> LETHALITY CONTRIBUTION DURING HEATING					
LETHALITY (MIN)		DISTANCE FROM SURFACE (m)		SPECIFY TARGET LETHALITY					
CENTER		NODE 1		TARGET LETHALITY					
NODE 2		NODE 3		3 MIN					
NODE 4		NODE 5							
NODE 6		NODE 7							
NODE 8		NODE 9							
NODE 10		SURFACE							

OUTPUT		TIME-TEMP CURVE		NUTRIENT RETENTION		LETHAL RATE CURVE		DISTRIBUTION	
REQUIRED HOLDING TIME		120.5 SEC		REQUIRED LENGTH OF HOLDING TUBE		237.9 m			
CENTER T (°C)	132.1	THIAMINE RETENTION (%)	94.2						
MASS AVERAGE T (°C)	137.2	LYSINE RETENTION (%)	98.5						
OVERALL QUALITY RETENTION (%)									
CARROTS	4.38E-01	POTATO	6.76E-01						

SOLVE

EXIT

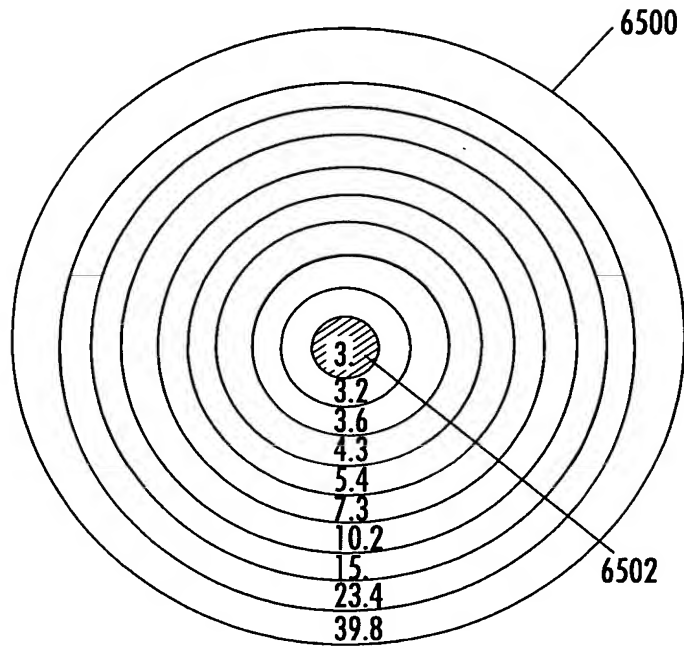
POTATO  
1/2 IN. X 1/2 IN.  
 $F_0(\text{CENTER}) = 3 \text{ MIN.}$   
TIME = 120.5 s  
(HOLDING ONLY)  
 $\alpha = 1.63 \times 10^{-7} \text{ m}^2/\text{s}$

FIG. 64

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POTATO  
1/2 IN. X 1/2 IN.

FIG. 65



Title: Methods, Systems, and Devices  
for Evaluation of Thermal Treatment  
Inventors: Palazoglu et al.  
Attorney Docket No. 297/164/2

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[illegible]

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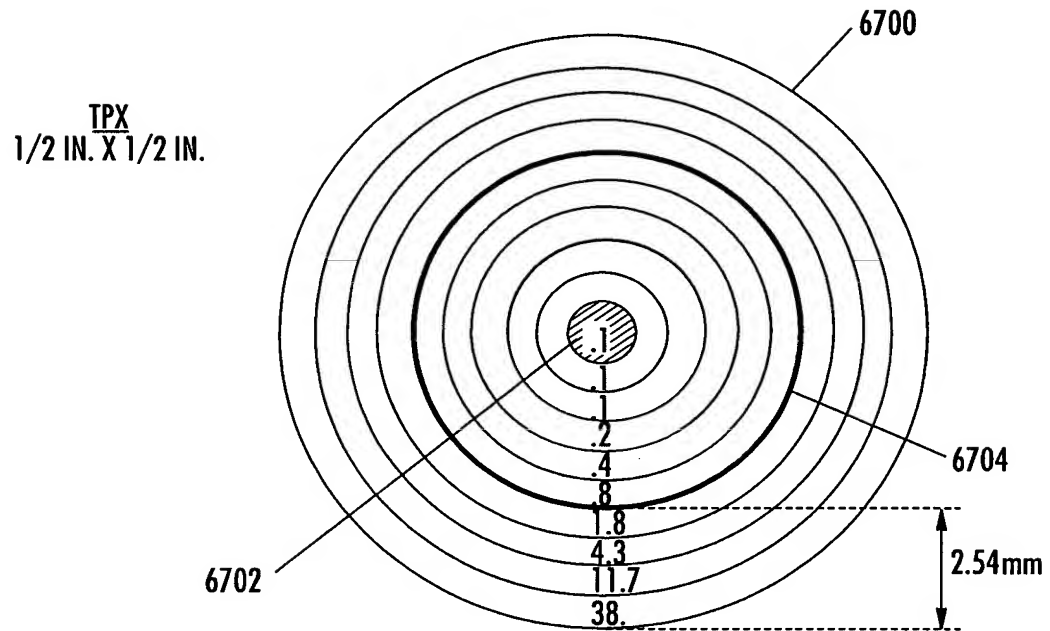


FIG. 67



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6800

MAPS® MULTIPHASE ASEPTIC PROCESSING SIMULATOR

PARTICLE		FLUID		HEATING		HOLDING		COOLING	
CYLINDRICAL		DENSITY (kg/m <sup>3</sup> )		$h_{tp}$ (W/m <sup>2</sup> -K)		FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C)		FLUID T INCREASES EXPONENTIALLY	
RADIUS (m)		SPECIFIC HEAT (J/kg-K)		HEATING TIME (SEC)		HEATING TIME (SEC)		FLUID T INCREASES LINEARLY	
HALF THICKNESS (m)		PRODUCT		CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER		SPECIFY HOLDING TIME		HOLDING TIME	
DENSITY (kg/m <sup>3</sup> )		PARTICLE LOAD (% BY VOLUME)		<input type="checkbox"/> THERMAL CONTRIBUTION DURING HEATING		1		120.5 SEC	
K (W/m-K)		FLOW RATE (L/s)		<input type="checkbox"/> LETHALITY CONTRIBUTION DURING HEATING					
SPECIFIC HEAT (J/kg-K)		INITIAL TEMPERATURE (°C)							

LETHALITY(MIN) DISTANCE FROM SURFACE (m)

CENTER NODE 1  
 NODE 2  
 NODE 3  
 NODE 4  
 NODE 5  
 NODE 6  
 NODE 7  
 NODE 8  
 NODE 9  
 SURFACE NODE 10

OUTPUT: TIME-TEMP CURVE LETHAL RATE CURVE DISTRIBUTION

F<sub>0</sub> 1.94 MIN

CENTER T (°C) 130.6 THIAMINE RETENTION (%) 93.8

MASS AVERAGE T (°C) 137.1 LYSINE RETENTION (%) 98.4

OVERALL QUALITY RETENTION (%)

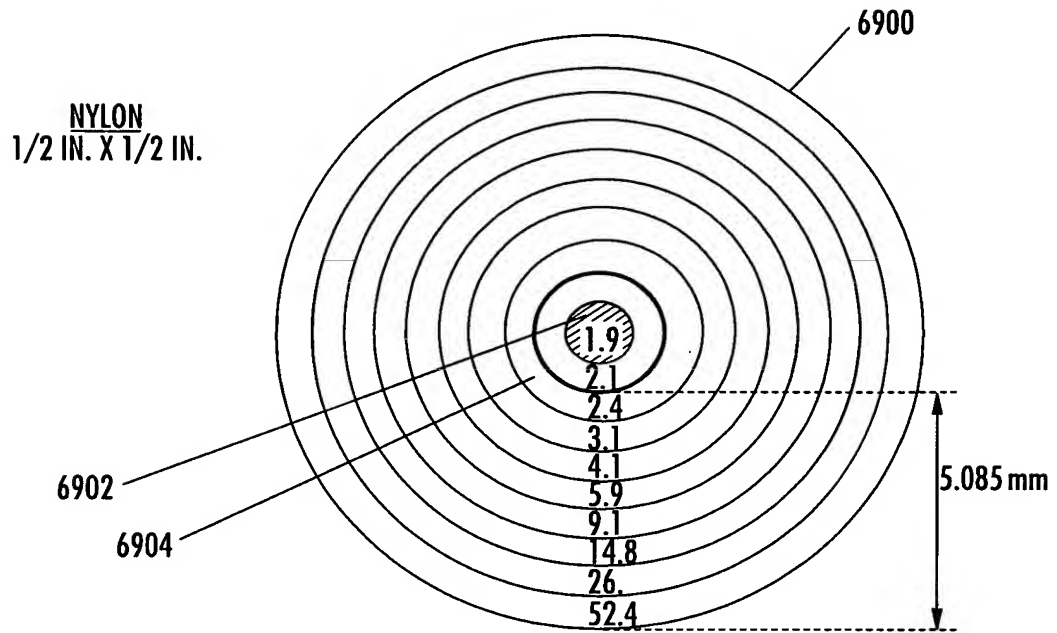
CARROTS 7.95E-01 POTATO 1.01E+00

SOLVE EXIT

NYLON  
 1/2 IN. X 1/2 IN.  
 TIME = 120.5 s  
 (HOLDING ONLY)  
 $\alpha = 1.40 \times 10^{-2} \text{ m}^2/\text{s}$

FIG. 68

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**FIG. 69**

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MAPS® - MULTIPHASE ASEPTIC PROCESSING SIMULATOR

CYLINDRICAL RADIUS (m) 0.00635 HALF THICKNESS (m) 0.00635		FLUID DENSITY (kgm <sup>-3</sup> ) 1000 SPECIFIC HEAT (J/kg-K) 3600		HEATING h <sub>tp</sub> (W/m <sup>2</sup> -K) 1000 HEATING TIME (SEC) 112		HOLDING FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C) 140 <input checked="" type="radio"/> FLUID T INCREASES EXPONENTIALLY <input type="radio"/> FLUID T INCREASES LINEARLY		COOLING	
PRODUCT PARTICLE LOAD (% BY VOLUME) 30 FLOW RATE (L/s) 2 INITIAL TEMPERATURE (°C) 20		LETHALITY(MIN) 2170 K (W/m-K) 0.25 SPECIFIC HEAT (J/kg-K) 1004		CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER <input type="checkbox"/> THERMAL CONTRIBUTION DURING HEATING <input type="checkbox"/> LETHALITY CONTRIBUTION DURING HEATING		OPTIONS SPECIFY HOLDING TIME 1 HOLDING TIME 120.5 SEC			

LETHALITY(MIN) DISTANCE FROM SURFACE (m)

CENTER	NODE 1	NODE 2	NODE 3	NODE 4	NODE 5	NODE 6	NODE 7	NODE 8	NODE 9	NODE 10
SURFACE										

OUTPUT: TIME-TEMP CURVE LETHAL RATE CURVE DISTRIBUTION

Fo 24 MIN

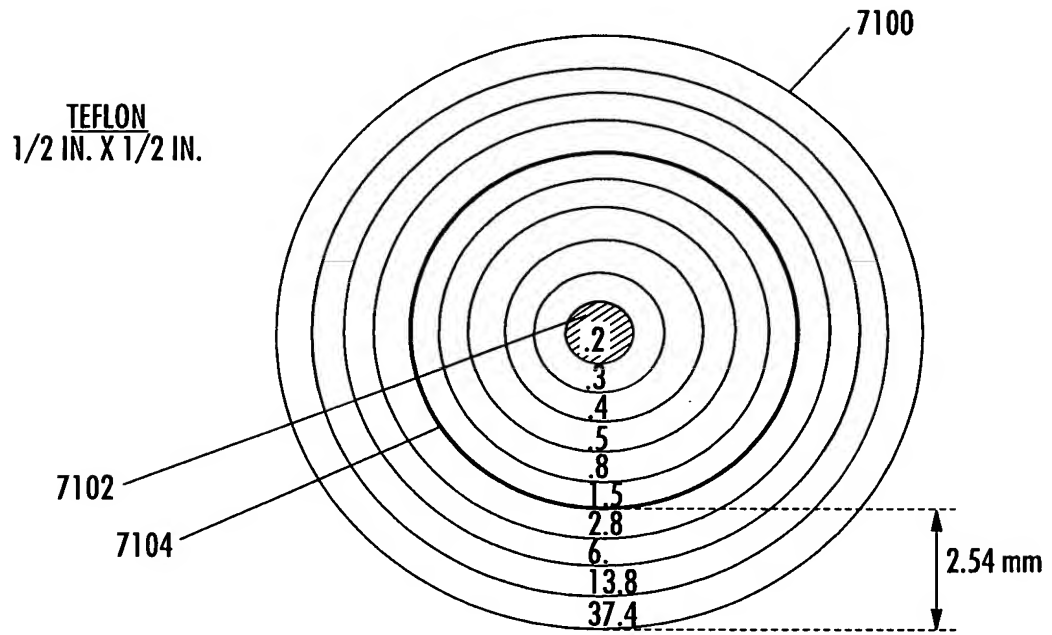
CENTER T (°C)	122.8	THIAMINE RETENTION (%)	95
MASS AVERAGE T (°C)	134.6	LYSINE RETENTION (%)	98.7
OVERALL QUALITY RETENTION (%)			
CARROTS	5.97E+00	POTATO	5.22E+00

SOLVE EXIT

TEFLON  
 1/2 IN. X 1/2 IN.  
 TIME = 120.5 s  
 (HOLDING ONLY)  
 $\alpha = 1.15 \times 10^{-7} \text{ m}^2/\text{s}$

FIG. 70

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**FIG. 71**

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7200

MAPS® MULTIPHASE ASEPTIC PROCESSING SIMULATOR

PARTICLE		FLUID		HEATING		HOLDING		COOLING	
[CYLINDRICAL]		DENSITY (kgm <sup>-3</sup> )	[1000]	$h_{tp}$ (W/m <sup>2</sup> ·K)	[1000]	FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C)		[140]	
RADIUS (m)	[0.00635]	SPECIFIC HEAT (J/kg·K)	[3600]	HEATING TIME (SEC)		[112]	<input checked="" type="radio"/> FLUID T INCREASES EXPONENTIALLY <input type="radio"/> FLUID T INCREASES LINEARLY		
HALF THICKNESS (m)		PRODUCT		CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER		SPECIFY HOLDING TIME		[120.5]	SEC
DENSITY (kgm <sup>-3</sup> )	[910]	PARTICLE LOAD (% BY VOLUME)	[30]	<input type="checkbox"/> THERMAL CONTRIBUTION DURING HEATING <input type="checkbox"/> LETHALITY CONTRIBUTION DURING HEATING		HOLDING TIME		[120.5]	SEC
K (W/m·K)	[0.13]	FLOW RATE (J/s)	[2]						
SPECIFIC HEAT (J/kg·K)	[2343]	INITIAL TEMPERATURE (°C)	[20]						

LETHALITY(MIN) DISTANCE FROM SURFACE (m)

CENTER NODE 1  
 NODE 2  
 NODE 3  
 NODE 4  
 NODE 5  
 NODE 6  
 NODE 7  
 NODE 8  
 NODE 9  
 SURFACE NODE 10

OUTPUT: TIME-TEMP CURVE LETHAL RATE CURVE DISTRIBUTION

FO MIN

CENTER T (°C) [84] THIAMINE RETENTION (%) [97.1]  
 MASS AVERAGE T (°C) [123] LYSINE RETENTION (%) [99.3]  
 OVERALL QUALITY RETENTION (%)  
 CARROTS [3.7E+01] POTATO [3.25E+01]

SOLVE EXIT

POLYPROPYLENE  
 1/2 IN. X 1/2 IN.  
 TIME = 120.5 s  
 (HOLDING ONLY)  
 $\alpha = 6.10 \times 10^{-8} \text{ m}^2/\text{s}$

FIG. 72

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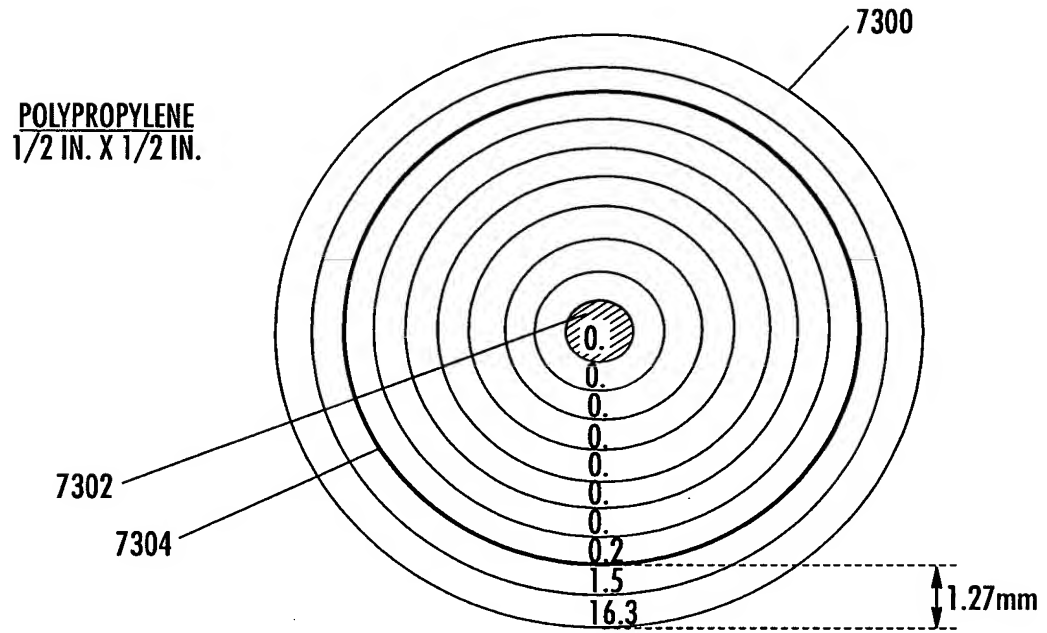
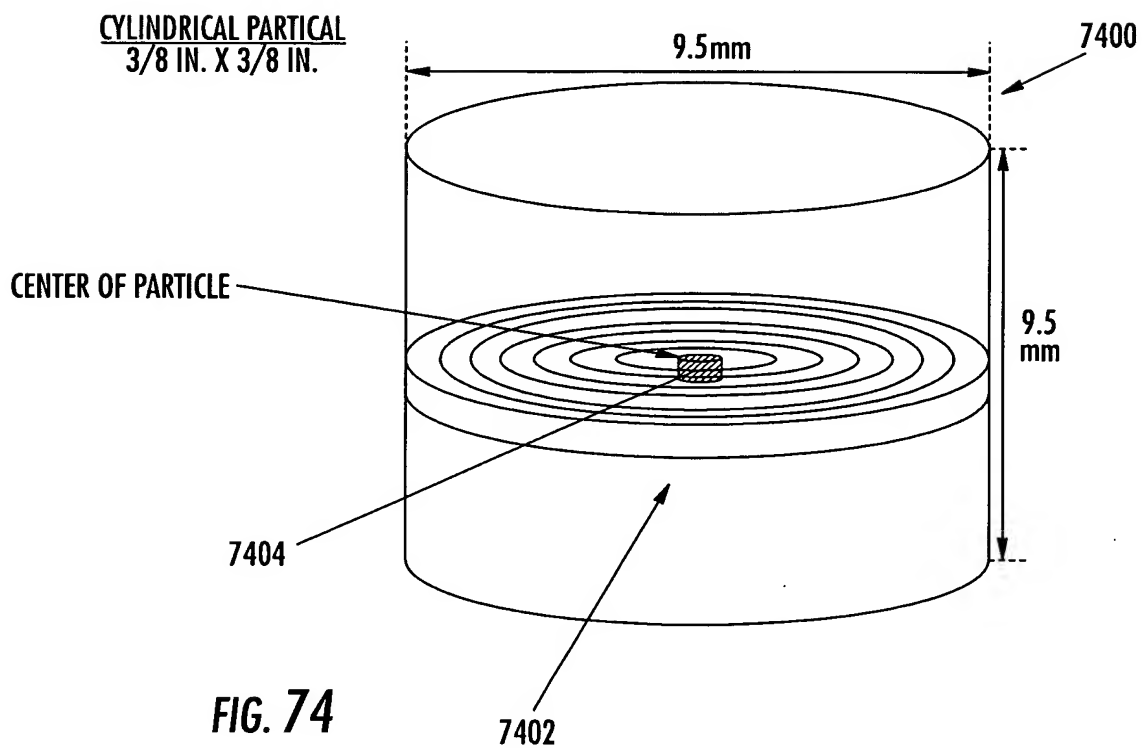


FIG. 73

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7500

MAPS® - MULTIPHASE ASEPTIC PROCESSING SIMULATOR

<b>PARTICLE</b> [CYLINDRICAL] <input checked="" type="checkbox"/> <input type="checkbox"/> RADIUS (m) <input type="text" value="0.0048"/> HALF THICKNESS (m) <input type="text" value="0.0048"/>		<b>FLUID</b> DENSITY (kg/m <sup>3</sup> ) <input type="text" value="1000"/> SPECIFIC HEAT (J/kg-K) <input type="text" value="3600"/>		<b>HEATING</b> h <sub>tp</sub> (W/m <sup>2</sup> -K) <input type="text" value="1000"/> HEATING TIME (SEC) <input type="text" value="112"/>		<b>HOLDING</b> FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C) <input type="text" value="140"/> <input checked="" type="radio"/> FLUID T INCREASES EXPONENTIALLY <input type="radio"/> FLUID T INCREASES LINEARLY		<b>COOLING</b>	
<b>PRODUCT</b> PARTICLE LOAD (% BY VOLUME) <input type="text" value="30"/> FLOW RATE (L/s) <input type="text" value="2"/> INITIAL TEMPERATURE (°C) <input type="text" value="20"/>		<b>LETHALITY (MIN)</b> <input type="text" value="30"/> <b>DISTANCE FROM SURFACE (m)</b> <input type="text" value="20"/>		<b>THERMAL AND LETHALITY CREDIT</b> CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER <input type="checkbox"/> THERMAL CONTRIBUTION DURING HEATING <input type="checkbox"/> LETHALITY CONTRIBUTION DURING HEATING		<b>OPTIONS</b> SPECIFY TARGET LETHALITY <input type="text" value="1"/> TARGET LETHALITY <input type="text" value="3"/> MIN			

OUTPUT:

REQUIRED HOLDING TIME  SEC  
 REQUIRED LENGTH OF HOLDING TUBE  m

CENTER T (°C)	<input type="text" value="133.7"/>	THIAMINE RETENTION (%)	<input type="text" value="98.2"/>
MASS AVERAGE T (°C)	<input type="text" value="137.6"/>	LYSINE RETENTION (%)	<input type="text" value="99."/>
OVERALL QUALITY RETENTION (%)			
CARROTS	<input type="text" value="1.04E+00"/>	POTATO	<input type="text" value="1.90E+00"/>

CENTER NODE 1  
 NODE 2  
 NODE 3  
 NODE 4  
 NODE 5  
 NODE 6  
 NODE 7  
 NODE 8  
 NODE 9  
 SURFACE NODE 10

POTATO  
 3/8 IN. X 3/8 IN.  
 F<sub>0</sub>(CENTER) = 3 MIN.  
 TIME = 76.0 s  
 (HOLDING ONLY)  
 $\alpha = 1.63 \times 10^{-7} \text{ m}^2/\text{s}$

FIG. 75



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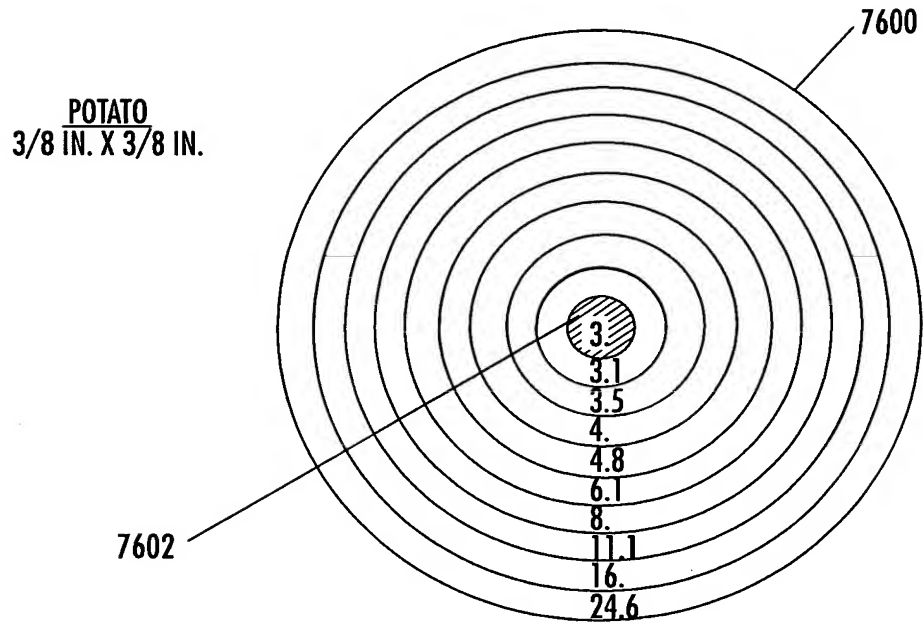


FIG. 76

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7700

MAPS® MULTIPHASE ASEPTIC PROCESSING SIMULATOR

PARTICLE		FLUID		HEATING		HOLDING		COOLING	
CYLINDRICAL		DENSITY (kgm <sup>-3</sup> )	1000	h <sub>tp</sub> (W/m <sup>2</sup> ·K)	1000	FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C)		140	
RADIUS (m)	0.0048	SPECIFIC HEAT (J/kg·K)	3600	HEATING TIME (SEC)		112	<input checked="" type="radio"/> FLUID T INCREASES EXPONENTIALLY <input type="radio"/> FLUID T INCREASES LINEARLY		
HALF THICKNESS (m)	0.0048	PRODUCT		THERMAL AND LETHALITY CREDIT		CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER		SPECIFY HOLDING TIME: 1 HOLDING TIME: 76 SEC	
DENSITY (kgm <sup>-3</sup> )	833	PARTICLE LOAD (% BY VOLUME)	30	<input type="checkbox"/> THERMAL CONTRIBUTION DURING HEATING <input type="checkbox"/> LETHALITY CONTRIBUTION DURING HEATING					
K (W/m·K)	0.17	FLOW RATE (L/s)	2	INITIAL TEMPERATURE (°C)		20			
SPECIFIC HEAT (J/kg·K)	1968								

LETHALITY(MIN) DISTANCE FROM SURFACE (m)

OUTPUT:	TIME-TEMP CURVE	NUTRIENT RETENTION	LETHAL RATE CURVE	DISTRIBUTION
CENTER	18 MIN	123.4	96.7	96.7
MASS AVERAGE T (°C)	134.9	99.2	99.2	99.2
CARROTS	9.85E+00	POTATO	9.63E+00	9.63E+00
OVERALL QUALITY RETENTION (%)				

SOLVE EXIT

TPX  
 3/8 IN. X 3/8 IN.  
 TIME = 76.0 s  
 (HOLDING ONLY)  
 $\alpha = 1.04 \times 10^{-7} \text{ m}^2/\text{s}$

FIG. 77

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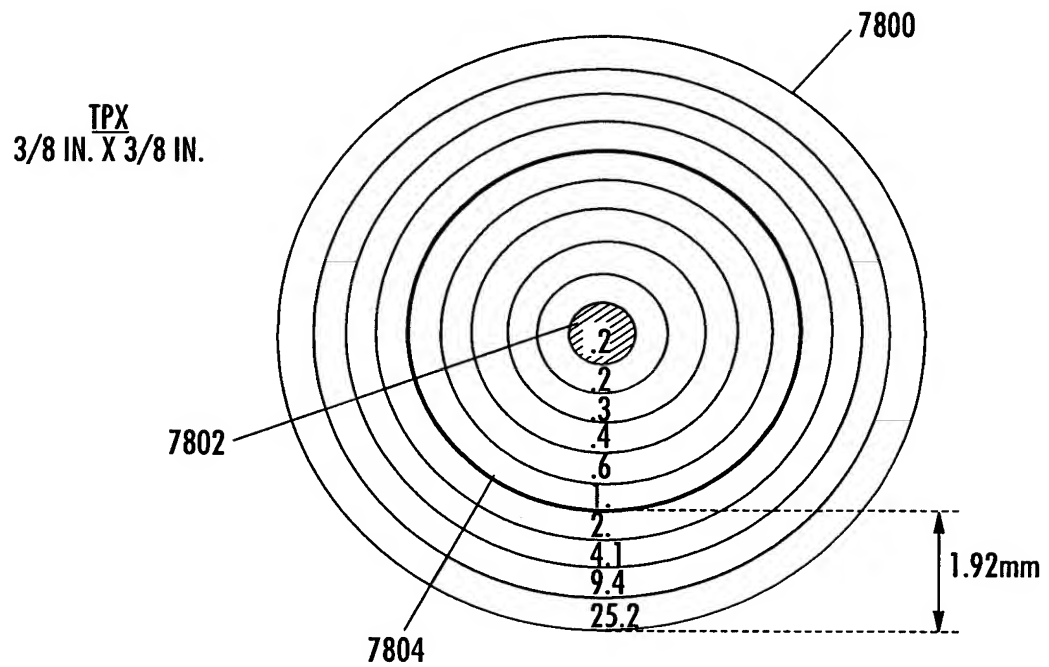


FIG. 78

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7900

MAPS® MULTIPHASE ASEPTIC PROCESSING SIMULATOR

PARTICLE		FLUID		HEATING		HOLDING		COOLING	
CYLINDRICAL		DENSITY (kg/m <sup>3</sup> )	1000	$h_{tp}$ (W/m <sup>2</sup> ·K)	1000	FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C)		140	
RADIUS (m)	0.0048	SPECIFIC HEAT (J/kg·K)	3600	HEATING TIME (SEC)		112	<input checked="" type="radio"/> FLUID T INCREASES EXPONENTIALLY <input type="radio"/> FLUID T INCREASES LINEARLY		
HALF THICKNESS (m)	0.0048	PRODUCT		THERMAL AND LETHALITY CREDIT		<input type="checkbox"/> THERMAL CONTRIBUTION DURING HEATING <input type="checkbox"/> LETHALITY CONTRIBUTION DURING HEATING		SPECIFY HOLDING TIME: 1 HOLDING TIME: 76 SEC	
DENSITY (kg/m <sup>3</sup> )	1120	PARTICLE LOAD (% BY VOLUME)	30	CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER					
$k$ (W/m·K)	0.24	FLOW RATE (L/s)	2	INITIAL TEMPERATURE (°C)		20			
SPECIFIC HEAT (J/kg·K)	1527	LETHALITY(MIN)		DISTANCE FROM SURFACE (m)					

OUTPUT: TIME-TEMP CURVE    NUTRIENT RETENTION    LETHAL RATE CURVE    DISTRIBUTION

Fo: 2.49 MIN

CENTER T (°C)	133.1	THIAMINE RETENTION (%)	95.8
MASS AVERAGE T (°C)	137.8 <td>LYSINE RETENTION (%) <td>98.9 </td></td>	LYSINE RETENTION (%) <td>98.9 </td>	98.9
OVERALL QUALITY RETENTION (%)			
CARROTS	1.15E+00	POTATO	1.91E+00

SOLVE    EXIT

NYLON  
 3/8 IN. X 3/8 IN.  
 TIME = 76.0 s  
 (HOLDING ONLY)  
 $\alpha = 1.40 \times 10^{-2} \text{ m}^2/\text{s}$

FIG. 79

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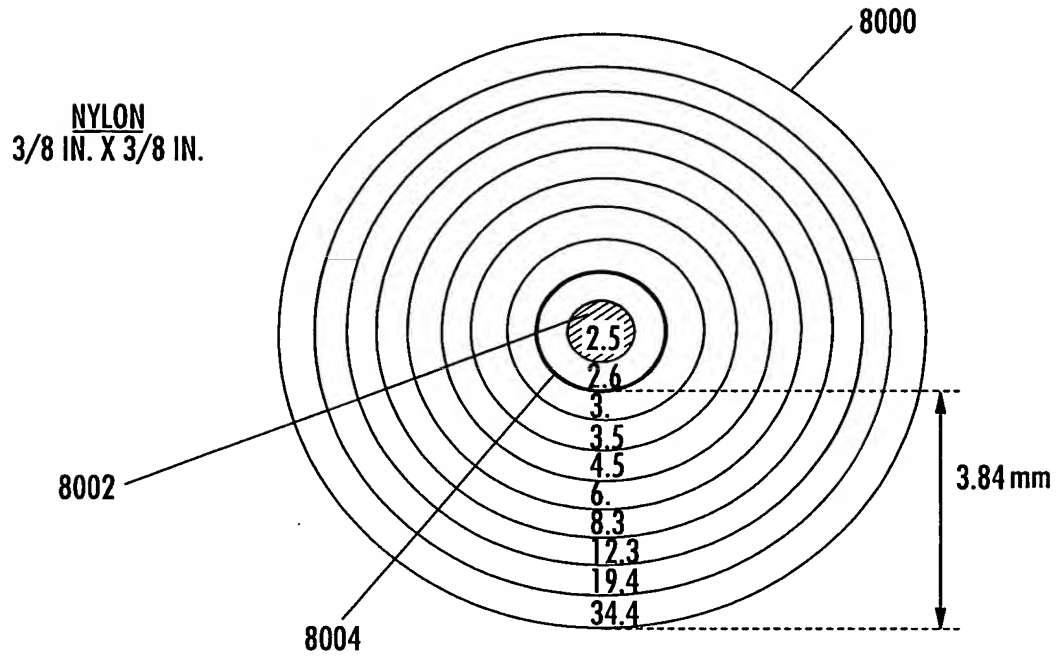


FIG. 80

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8100

MAPS® MULTIPHASE ASEPTIC PROCESSING SIMULATOR

PARTICLE		FLUID		HEATING		HOLDING		COOLING	
CYLINDRICAL		DENSITY (kg/m <sup>3</sup> )	1000	$h_{tp}$ (W/m <sup>2</sup> -K)	1000	FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C)		140	
RADIUS (m)	0.0048	SPECIFIC HEAT (J/kg-K)	3600	HEATING TIME (SEC)		<input checked="" type="radio"/> FLUID T INCREASES EXPONENTIALLY <input type="radio"/> FLUID T INCREASES LINEARLY			
HALF THICKNESS (m)	0.0048	PRODUCT		HEATING TIME (SEC)		112			
DENSITY (kg/m <sup>3</sup> )	2170	PARTICLE LOAD (% BY VOLUME)	30	THERMAL AND LETHALITY CREDIT		<input type="checkbox"/> THERMAL CONTRIBUTION DURING HEATING <input type="checkbox"/> LETHALITY CONTRIBUTION DURING HEATING		SPECIFY HOLDING TIME: 1 HOLDING TIME: 76 SEC	
K (W/m-K)	0.25	FLOW RATE (L/s)	2	CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER					
SPECIFIC HEAT (J/kg-K)	1004	INITIAL TEMPERATURE (°C)	20						

LETHALITY (MIN) DISTANCE FROM SURFACE (m)

OUTPUT: TIME-TEMP CURVE NUTRIENT RETENTION LETHAL RATE CURVE DISTRIBUTION

Fo 39 MIN

CENTER T (°C)	126.41	THIAMINE RETENTION (%)	96.6
MASS AVERAGE T (°C)	135.6 <td>LYSINE RETENTION (%)</td> <td>99.1 </td>	LYSINE RETENTION (%)	99.1
OVERALL QUALITY RETENTION (%)			
CARROTS	6.79E+00	POTATO	7.13E+00

CENTER NODE 1  
 NODE 2  
 NODE 3  
 NODE 4  
 NODE 5  
 NODE 6  
 NODE 7  
 NODE 8  
 NODE 9  
 SURFACE NODE 10

SOLVE EXIT

TEFLON  
 3/8 IN. X 3/8 IN.  
 TIME = 76.0 s  
 (HOLDING ONLY)  
 $\alpha = 1.15 \times 10^{-2} \text{ m}^2/\text{s}$

FIG. 81

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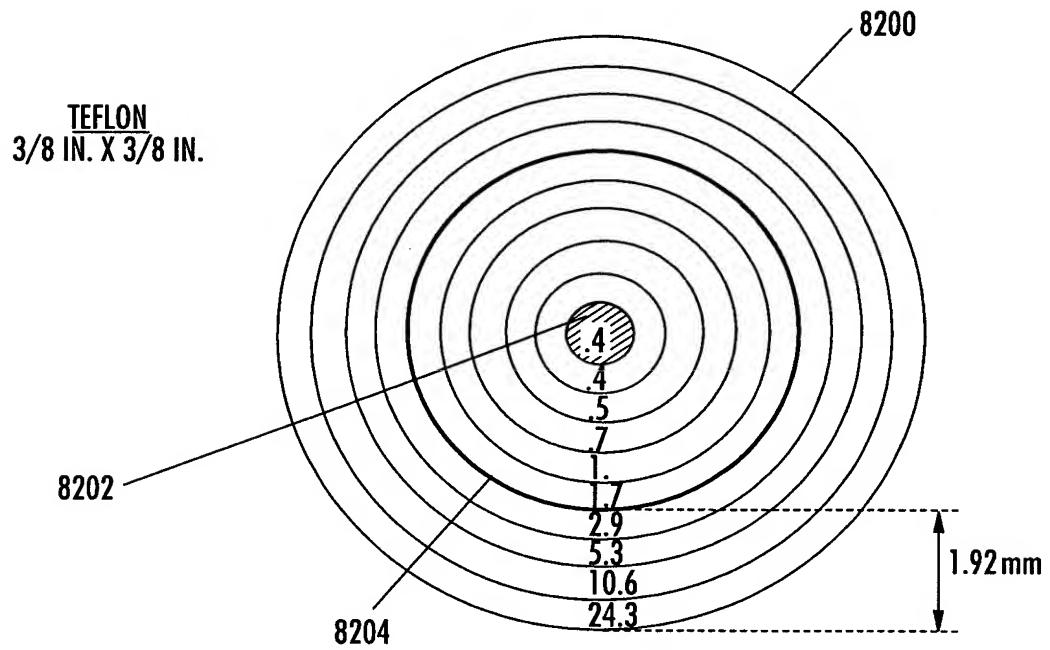


FIG. 82

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8300

MAPS® MULTIPHASE ASEPTIC PROCESSING SIMULATOR

PARTICLE

CYLINDRICAL

RADIUS (m)

0.0048

HALF THICKNESS (m)

0.0048

FLUID

DENSITY (kg/m<sup>3</sup>)

1000

SPECIFIC HEAT (J/kg·K)

3600

PRODUCT

PARTICLE LOAD (% BY VOLUME)

30

FLOW RATE (L/s)

2

INITIAL TEMPERATURE (°C)

20

HEATING

$h_{tp}$  (W/m<sup>2</sup>·K)

1000

HEATING TIME (SEC)

112

COOLING

FLUID TEMPERATURE AT HEAT EXCHANGER EXIT (°C)

140

FLUID T INCREASES EXPONENTIALLY

FLUID T INCREASES LINEARLY

HEATING AND LETHALITY CREDIT

CHECK BOXES TO ACCOUNT FOR NORMAL AND/OR LETHALITY CONTRIBUTION WITHIN HEAT EXCHANGER

THERMAL CONTRIBUTION DURING HEATING

LETHALITY CONTRIBUTION DURING HEATING

SPECIFY HOLDING TIME

HOLDING TIME

76

 SEC

OUTPUT

TIME-TEMP CURVE

NUTRIENT RETENTION

LETHAL RATE CURVE

DISTRIBUTION

FO

MIN

CENTER T (°C)

91.1

THIAMINE RETENTION (%)

98.1

MASS AVERAGE T (°C)

125

LYSINE RETENTION (%)

99.5

OVERALL QUALITY RETENTION (%)

CARROTS

3.92E+01

POTATO

3.56E+01

CENTER

NODE 1

NODE 2

NODE 3

NODE 4

NODE 5

NODE 6

NODE 7

NODE 8

NODE 9

SURFACE

NODE 10

LETHALITY(MIN)

DISTANCE FROM SURFACE (m)

SOLVE

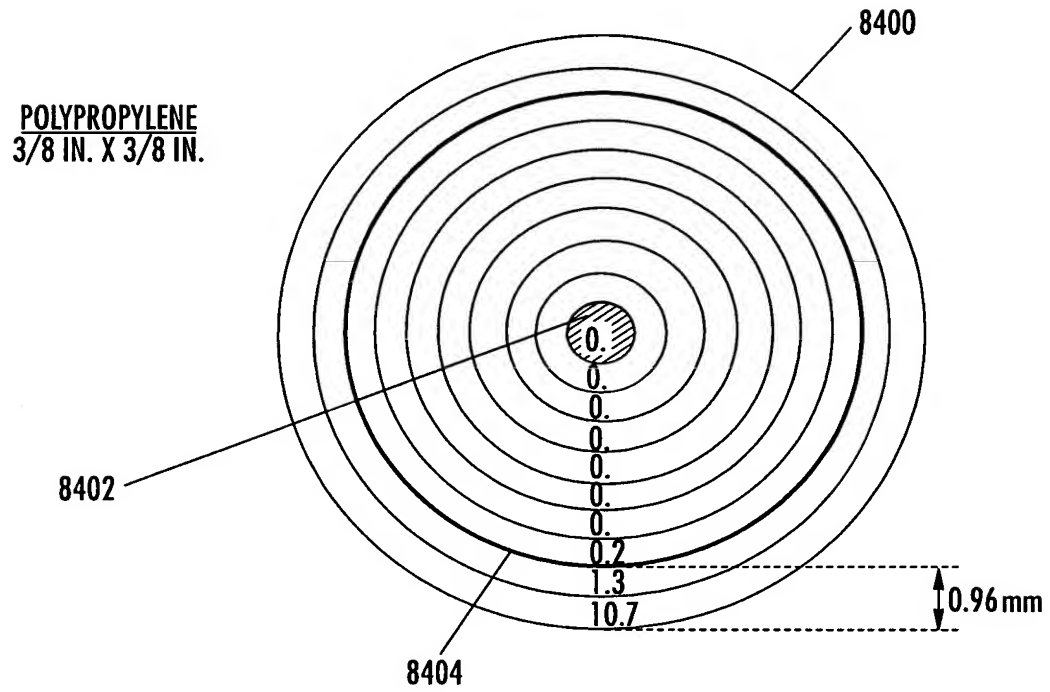
EXIT

POLYPROPYLENE  
3/8 IN. X 3/8 IN.  
TIME = 76.0 s  
(HOLDING ONLY)  
 $\alpha = 6.10 \times 10^{-8} \text{m}^2/\text{s}$

FIG. 83



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**FIG. 84**

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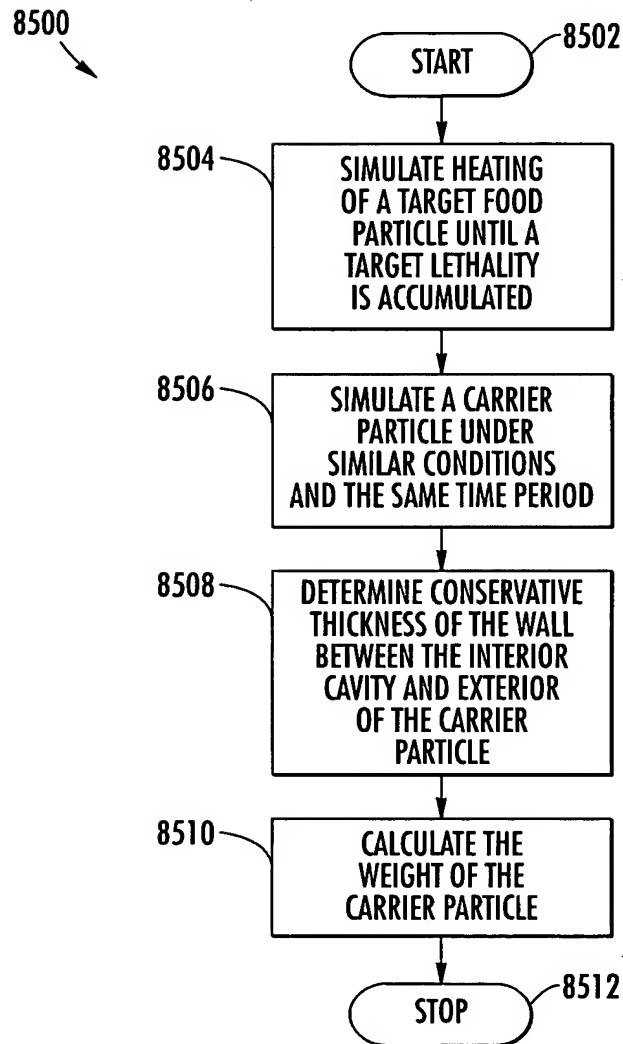


FIG. 85

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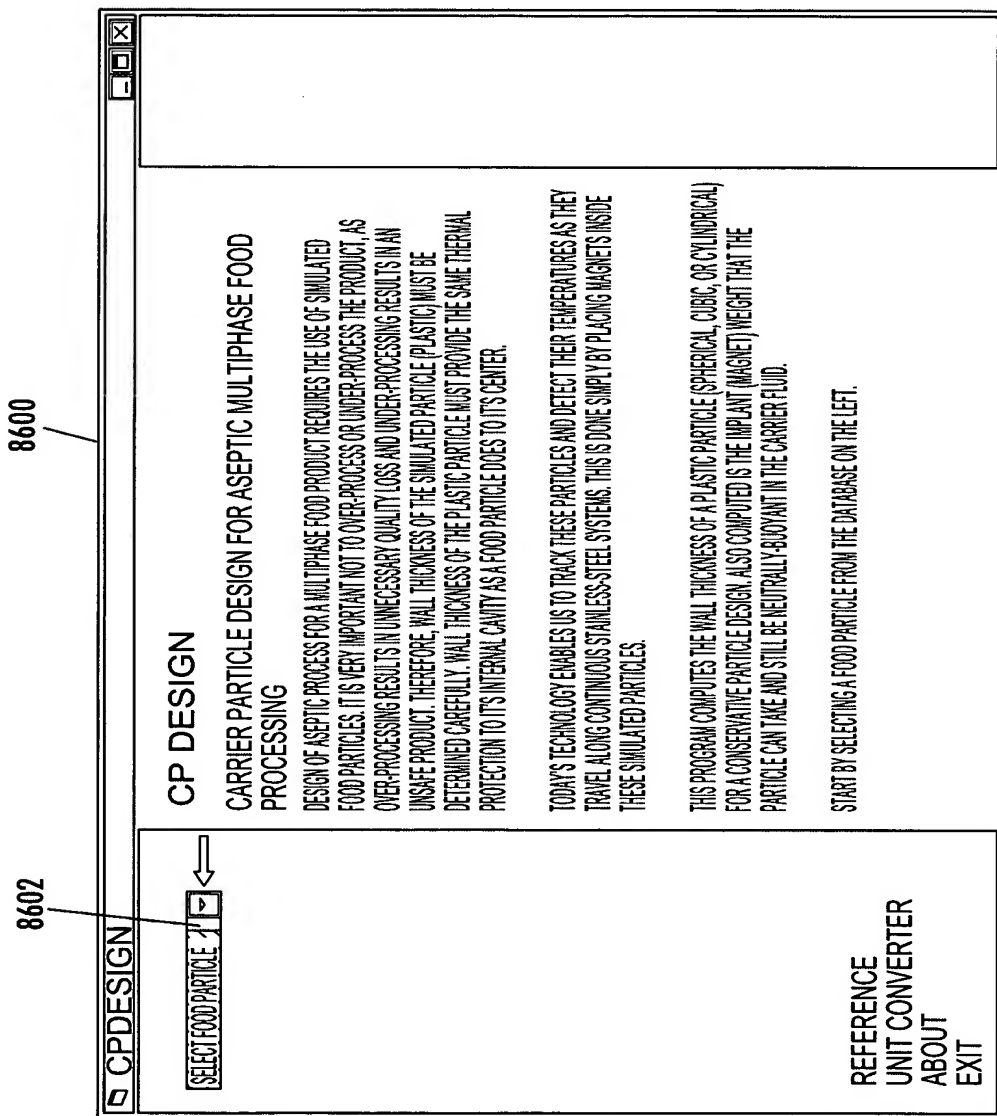


FIG. 86

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8700

CPDESIGN

FOOD PARTICLE

POTATO

PLASTIC MATERIAL

TPX

PARTICLE SHAPE

CYLINDRICAL

REFERENCE

UNIT CONVERTER

ABOUT

EXIT

DENSITY=

1,090 kgm<sup>3</sup>

THERMAL CONDUCTIVITY=

0.554 W/mK

SPECIFIC HEAT=

3,517 J/kgK

DENSITY=

833 kgm<sup>3</sup>

THERMAL CONDUCTIVITY=

0.17 W/mK

SPECIFIC HEAT=

1,988 J/kgK

CYLINDRICAL PARTICLE

RADIUS

FOOD PARTICLE

PLASTIC PARTICLE

HALF THICKNESS

FOOD PARTICLE

PLASTIC PARTICLE

0.00635 m

0.00635 m

0.00635 m

0.00635 m

PROCESS VARIABLES AND DESIRED  $f_0$

INITIAL PARTICLE TEMPERATURE

20 °C

Ambient Temperature

140 °C

HEAT TRANSFER COEFFICIENT

1000 W/m<sup>2</sup>K

DESIRED  $f_0$

3 MIN

CALCULATION OF MAXIMUM IMPLANT WEIGHT

TARGET PARTICLE DENSITY

1000 kgm<sup>3</sup>

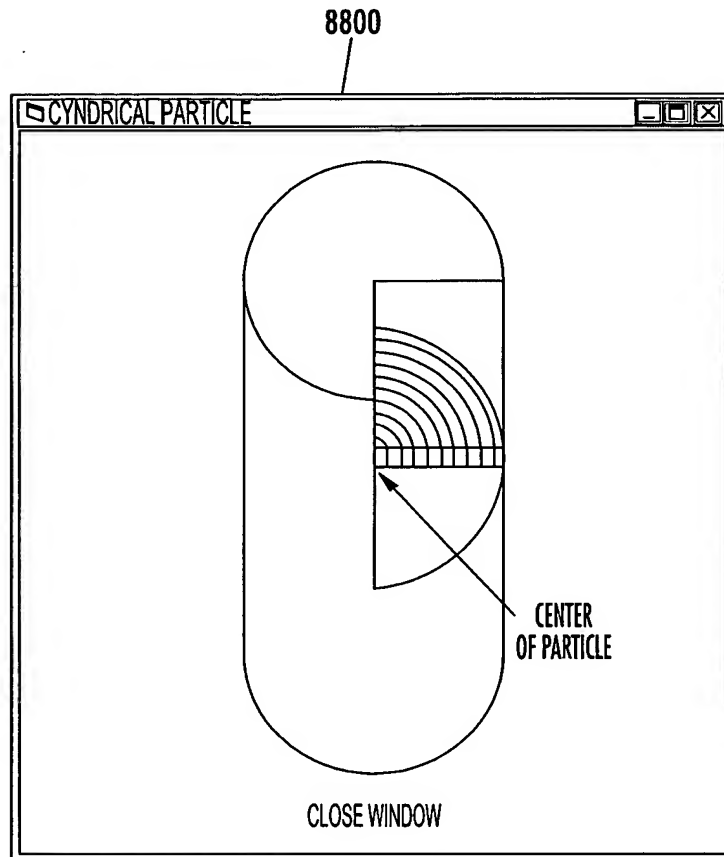
START

BASED ON THE COMPUTED WALL THICKNESS OF THE PLASTIC PARTICLE AND THE TARGET PARTICLE DENSITY, THE MAXIMUM IMPLANT WEIGHT CAN BE 411 G.

PRINT RESULTS

FIG. 87

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**FIG. 88A**

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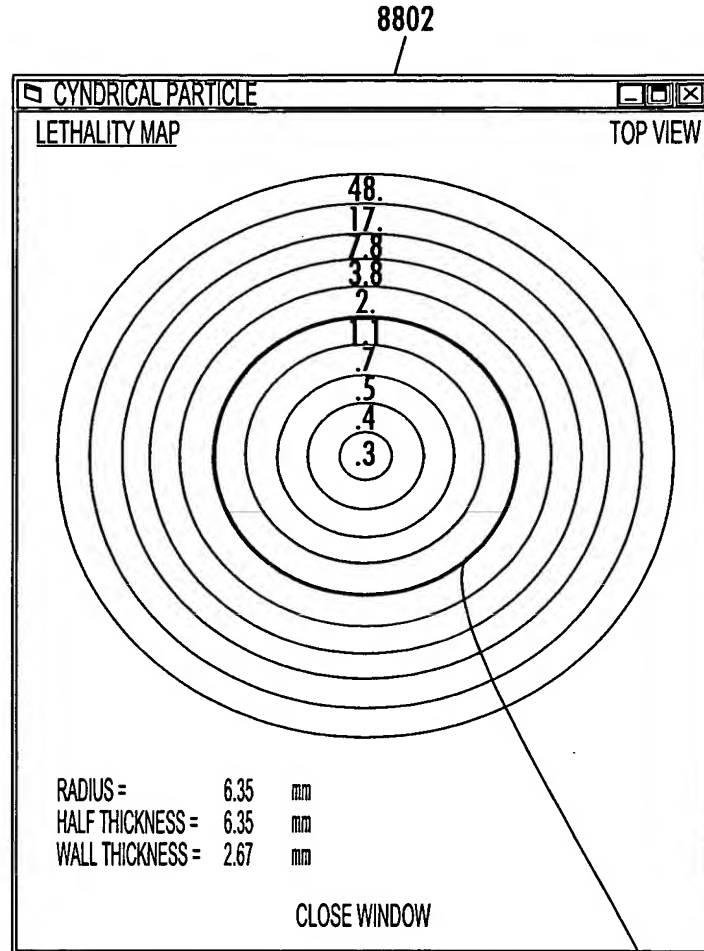
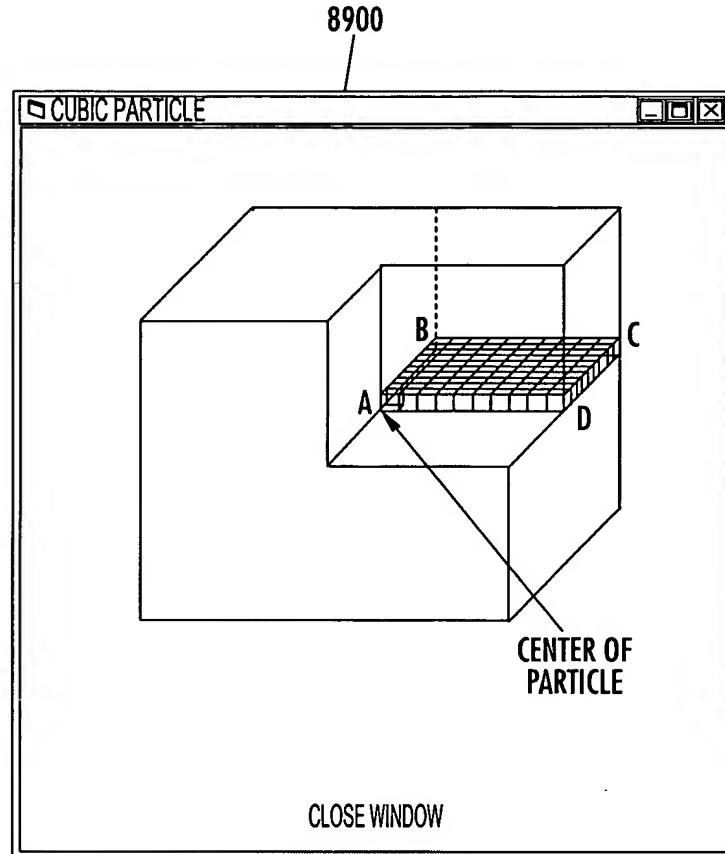


FIG. 88B

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**FIG. 89A**

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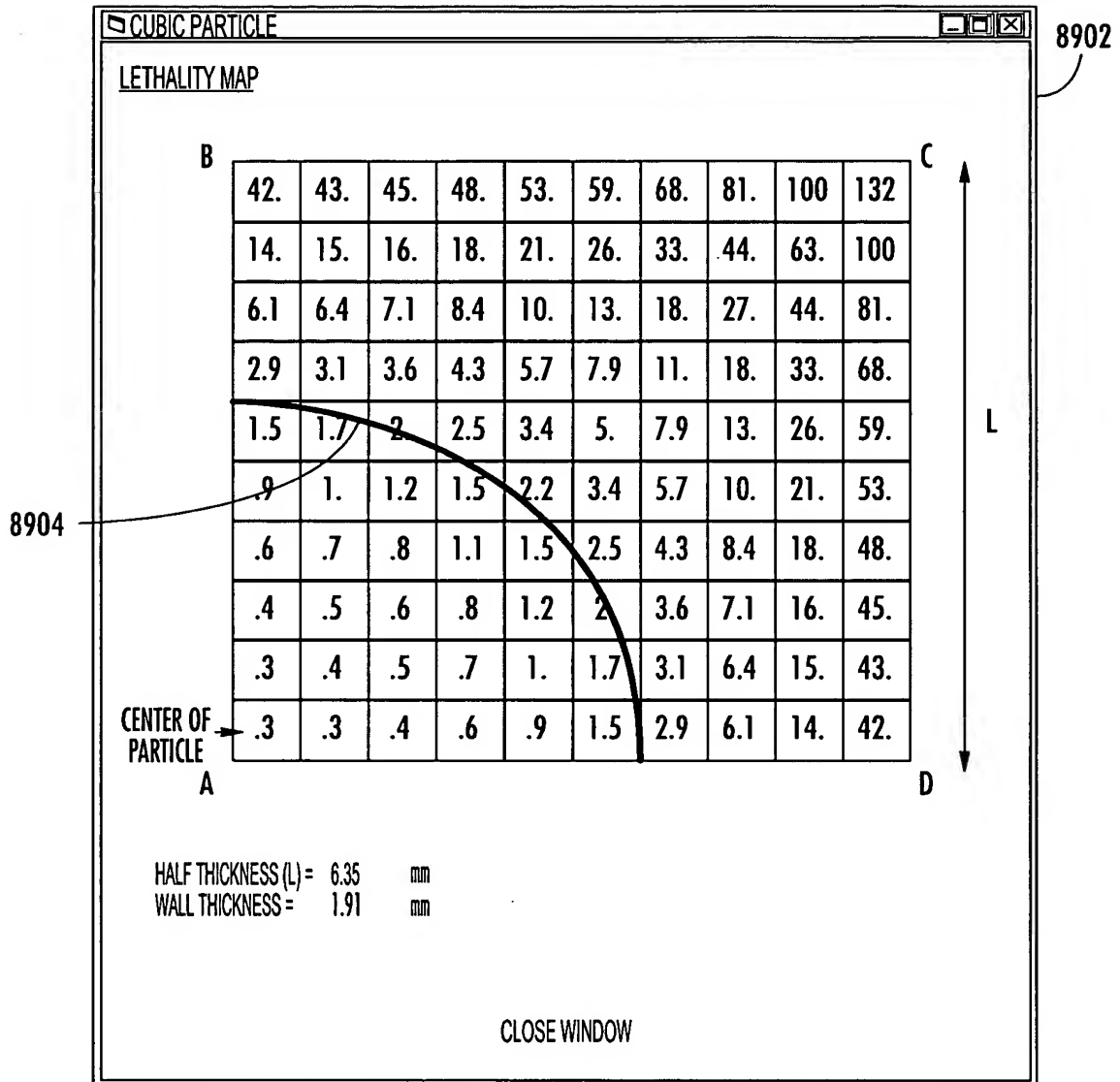
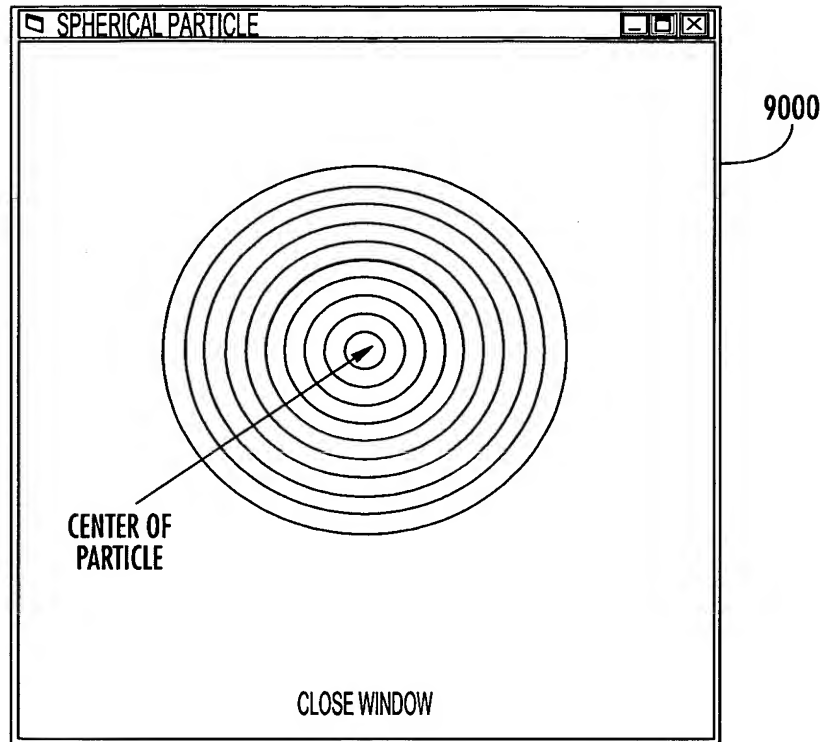


FIG. 89B



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**FIG. 90A**

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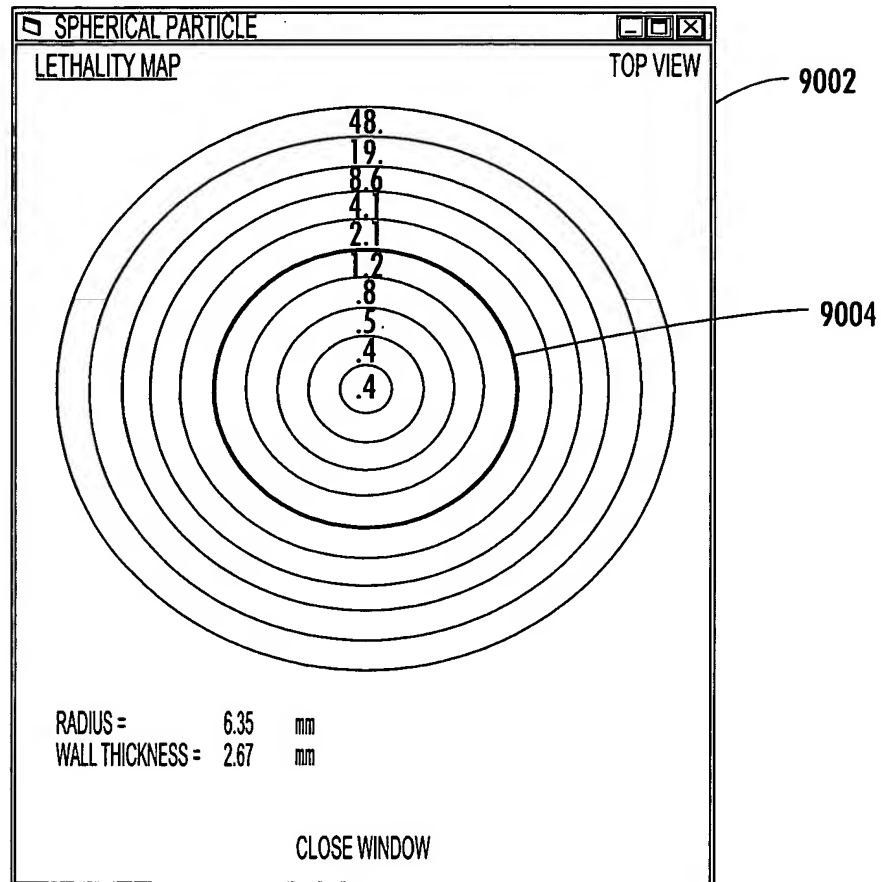


FIG. 90B